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The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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Silicosis and Sand-Blasting

The Annual Report of the Chief Inspector for Factories and Workshops for 1933 contains a very serious charge against sand-blasting as a dangerous process. It will perhaps be noted that we have not reproduced the tabular matter in our abstract of the Report, printed elsewhere in this issue, because we thought that readers might be misled into imagining that 37 sandblasters died last year from silicosis, and this disease was accompanied by tuberculosis. These are not the total deaths from the diseases in any one year or group of years, but have been collected during the last few years.

All manufacturers are unanimous in their desire to minimise the risk to which their employees are exposed, but in this material world there have to be faced a number of hard facts, which are of such importance that they affect industry as a whole—that means both employer and employee. The commendable progress made by the manufacturers of sand-blast apparatus and the dust-collecting contrivances associated therewith is unofficially recognised by the factory inspectorate, but in this Report the whole system of sand- and shot-blasting is attacked. Yet there is a tacit recognition that foundry owners have to meet competition from abroad, and Home Office regulations of too onerous a character would favour any foreign manufacturer more lightly treated. Dr. Merewether, in concluding his Report, states "the possibility of an international agreement . . . to safeguard the workers from the risk inherent in the process of sand-blasting seems very remote, but that it is necessary to protect the workers in all countries where sand-blasting is carried out I have no doubt." The foundry owners of the principal nations are reasonably well organised, are amenable to reason, and from personal contact with their leaders we can state that, if approached, they would take part in a conference to discuss any proposals the British might put forward for the general amelioration of the situation. No manufacturer, be he British or foreign, wishes to expand his export trade at the expense of the health of his operatives. We are very well aware from personal observation that lapses in intelligent factory inspection are to be encountered on the Continent, but, on the other hand, voluntary "safety-first" activities are making great headway, compensating very largely the lack of official pressure. It is to be hoped that, before further Home Office regulations are imposed, an effort will be made on the lines suggested (but with such little hope of success) by Dr. Merewether.

The Foundry and the Traffic Problem

With the Road Transport Bill receiving the Royal Assent this week, and the toll of the roads increasing, it is appropriate to remember how much the foundry industry contributes to the solution of traffic-control problems, quite apart from its widespread interest in the automobile industry and the more recently developed application to road surfaces. In this last-mentioned connection an interesting report was recently received from Germany to the effect that at Duisberg a kind of cast-iron asphalt made of cast-iron dust is being poured on the roads in fluid form, with the object of yielding, on setting, a non-skid surface. Possibly this may provide a solution to the problem of profitably disposing of cast-iron scrap in the form of swarf, borings and turnings. We had, however, principally in mind the use made of castings in the form of pillars for guiding, signalling and otherwise controlling traffic, both vehicular and pedestrian. This application has in a remarkably short space of time assumed large proportions, and possibly makes up for a falling-off in cast-iron lamp posts and electric overhead-wire standards, which is bound to come with the growth for overhead lighting, and with the decline of the electric tramcar as a means of locomotion. It is very satisfactory to see the prominent part the foundry industry has taken in these traffic developments. When receiving the Messel Memorial Medal at Cardiff recently, Sir Harry McGowan, chairman of I.C.I., made an interesting suggestion. It was the establishment of a road-accident research department, made possible by the statistics now collected. For example, he asked how far the accident rate could be correlated with the height of the driver's eyes above street level. In some cars, the driver could only see the road about thirty feet in front of him on account of the long, high bonnet and the headlamps. Reverting to the use of castings in traffic-control apparatus, this is a case where cast iron serves its purpose admirably. Its rigidity is such as to offer no temptation to risk impact, but if an impact did take place, the fragility of the metal, like that of a manhole cover under sudden and unexpected internal pressure, would cause rupture without too much resistance, and hence without too much damage to a car and risk to its occupants.

XUM

Non-Ferrous Metals at A.S.T.M. Annual Meeting

At the session of the A.S.T.M. annual meeting held at Atlantic City from June 25 to 29, devoted to non-ferrous metals, reports of six committees functioning in various phases of this field were presented and three interesting technical Papers were given.

An outstanding report was presented by Committee B-7 on Light Metals and Alloys, representing an exhaustive compilation of data on the "Service Characteristics of Light Metals and Alloys." Its purpose is to provide the engineering profession with an accurate picture of the light-metal industry, discussing aluminium and magnesium and alloys under such heads as Metallurgical Characteristics, Industrial Requirements, Surface Protection and Tabular Data. The latter involve some 17 tables giving valuable information on physical and mechanical properties, compositions, etc.

"The Impact Strength of Commercial Zinc Alloy Die Castings" was discussed by E. A. Anderson and G. L. Werley, of the New Jersey Zinc Company. The question has been raised on many occasions as to whether properties of commercial die castings approximate those of test specimens cast to size. The impact tests were carried out on over 500 test-bars machined from 77 commercial die castings. All of the specimens tested were cut so as to include one unmachined die-cast face and in the test this face was always in tension. The authors conclude that so far as impact strength is concerned, close agreement exists between properties of die-cast bars and of sections cut from the surface of die castings. No further conclusions were drawn from the extensive data. It was pointed out that with the exception of three parts, the specimens represented at least one-half of the total thickness of the castings investigated.

Committee B-6 on Die-Cast Metals and Alloys in its report recommended new specifications for magnesium-base alloy die castings, and these were approved by the Society session as an A.S.T.M. tentative standard. The committee has conducted a questionnaire to determine whether there exists sufficient demand to justify specifications covering ingots intended for the manufacture of die castings. The replies indicate that such specifications would supply a very definite need, and the committee contemplates the addition of other ingot alloys to existing Specifications for Aluminium-Base Sand-Casting Alloys in Ingot Form (B 58-33 T).

Appended to the report of the committee was a Paper on "The Effect of Variations in Aluminium Content on the Strength and Permanence of the A.S.T.M. No. XXIII Zinc Die-Casting Alloy." Ever since the commercial introduction of this alloy, there has been a pronounced desire to increase aluminium content in the interest of better castability. Of the properties measured the impact strength was most important, and as a result of the 10-day steam test which is the most practical means of evaluating the permanence of impact strength, it was indicated that the aluminium content of the alloy should be definitely limited to a maximum of 4.4 per cent. It is not unusual to find deviations of 0.1 per cent. from the true aluminium content and for this reason the authors favour placing the maximum at 4.3 per cent. Whereas this work was started in an effort to find out whether the maximum limit for this alloy could be raised, the tests indicate the desirability of a reduction from the present value 4.5 to the lower value, 4.3.

During the year the sub-group in charge of the extensive series of exposure and corrosion tests has inspected all of the die-cast specimens which have been on the racks for over four years at the six locations. One set of the specimens will be put through physical tests in June of next year at which time information on changes in tensile strength or other physical properties can be drawn.

R. L. Templin, Chief Engineer of Tests, Aluminum Company, of America, who was awarded the 1934 Dudley Medal in recognition of his outstanding Paper given at the Society's meeting in Chicago last year, presented a Paper "Some Factors Affecting Strain Measurements in Tests of Metals," based on results of a large number of tests carried out to afford a comparison of deformations on various elements of both tension and compression specimens of various forms in both the elastic and plastic ranges. The metals used for the tests were high-strength wrought aluminium alloys, but quite similar results would be anticipated with any other metals having similar stress-strain characteristics such as cold-worked copper or steel, nickel, alloys of magnesium, stainless steel and others. After describing the tests and summarising results, Mr. Templin concluded that considerable variations in strain and stress are to be anticipated in both tension and compression specimens, even using careful technique and good apparatus, but the results indicated definitely the necessity for uniform and axial loading of specimens.

Publication Received

Economic Conditions in Germany. Report by J. W. F. Thelwall, C.M.G., M.C. Published through the Department of Overseas Trade by H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. Price 3s. 6d. net.

Since the creation of the National Socialist Government by Herr Hitler, we have tried to follow the kaleidoscopic changes by a study of the reports as they appear in the responsible daily Press, but we confess that our impressions were sketchy until we had the privilege of reading Mr. Thelwall's Report. Even now it is difficult to judge whether developments are leading towards more or less freedom for the individual manufacturer. Some of the innovations seem to the British mind to be bordering on *opéra bouffe*. Amongst these we note the State Chamber of Culture, and the National Socialistic Strength Through Joy. These are actually two of the most important organisations in Germany at the moment. Unquestionably a very real revolution has taken place in Germany, but no doubt in the long run we shall find the Germans doing very much the same as they always did, but the technique of performance has been varied. For instance, in England, a workman might be "carpetted" by his employer or his trade union, but in Germany apparently they now only possess one "mat" between them.

Whilst these economic reports are extremely interesting, we personally, for European conditions, would welcome the deletion of "Hints for Commercial Visitors," and its replacement by information as to the relative burdens placed on industry by factory regulations. Moreover, whilst we are told just what the State is spending on social services, it would be interesting to learn what national and local taxation costs the manufacturer per ton of steel ingots. These reports can never be perfect from everybody's viewpoint, but they are certainly extremely intelligently compiled, and must involve a great amount of labour for our commercial counsellors and their staffs.

MESSRS. D. & W. HENDERSON & COMPANY, LIMITED, Partick, Glasgow, have received an order from Messrs. T. & J. Harrison, Liverpool, for a cargo steamer of about 9,400 tons deadweight. Messrs. Henderson will also construct and install the machinery, of the triple-expansion type. The firm have now more work on hand than the number of berths available.

Random Shots

If "Marksman" were to be asked which was the oldest joke he could remember he would probably pick upon the one about the man who thought he could smell gas leaking and went into the cellar with a candle to look for the leak. . . . The up-to-date version of the story, of course, tells of the young man who—his car having broken down at night—lights his cigarette-lighter to see whether the petrol tank is empty. . . ." Marksman" has often read of what precautions must be taken in soldering or welding petrol tanks and containers, even when (apparently) empty. It was with surprise that, in an American contemporary, he read that leaky petrol tanks, with leaks above the petrol level, and with gas still in the tank, can be welded without the welder being "blown to kingdom come." An inexpensive non-explosive gas is forced into the leaky tank, replacing the air, and, of course, no air, no explosion. The patentee of the process has faith in it—has thrust a lighted blowpipe into the tank without anything happening.

* * *

A SALINE ROMANCE.

(AS RECOUNTED IN "CONCORD.")

There was a gay young metal,
As Sodium known to fame,
She fell in love with Chlorine,
Who proved her ready game.

One eve as they were strolling
Their periodic way,
They met Potassium Nitrate,
And passed the time of day.

Now Sodium was fickle,
The Nitrate she loved, too;
And Chlorine loved Potassium,
Adored her flame of blue.

So back and forth these couples changed;
In fact, they're changing still,
An incomplete reaction,
One called reversible.

But what if Mistress Silver
Should with the Nitrate pair,
This lunar caustic couple
Go out to take the air?

Should Sodium Chloride spy them,
The result—precipitate—
AgCl forever more,
An irreversible state.

MARKSMAN.

THE FALKIRK IRON COMPANY, LIMITED, have removed their offices and warehouse at Glasgow from Bothwell Street to 41, St. Vincent Place.

THE ALPIN MONTAN STEELWORKS, the largest metallurgical concern in Austria, is to undergo drastic internal reorganisation, in order to eliminate the political element which has dominated the management of the concern for some time past and made it a centre of opposition to the Austrian Government. The managing director, a German, has been arrested, and a governing commissioner with full powers is to be appointed in his place by the Government.

Some Factors Influencing the Density and Soundness of Ferrous and Non-Ferrous Castings*

By E. Longden (Foundry Manager, Craven Bros. (Manchester), Limited)

To attempt to describe exhaustively the influences controlling the density and soundness of castings would be, indeed, a great task. It is, therefore, the author's intention, whilst referring to some general influences of elements in metal, to deal with such unsoundness and low density which can be attributed to dissolved and occluded gases in a metal, along with gases generated and evolved from the mould materials, and the influence of mould materials on the constitution of cast metal alloys.

Considerations of specific gravity, or comparative density, are complex. Density can be defined as the mass weight per unit of volume, or the ratio of weight in a body to bulk compared with a standard substance—water. Unsoundness covers a multitude of faults in cast metals, but mention here is made of the lack of compactness of a metal due to gas and liquid shrinkage; therefore, for the purpose of this Paper, unsoundness can be defined as the lack of compactness which appears as visible porosity and cavity. Porosity is a matter of degree, since all substances possess porosity. Such considerations are linked with strength, hardness and wear, etc.

The relationship of density to strength is only comparative in a particular range of alloys or metals. Generally, strength and hardness increase with an increase in compactness of crystal structure until a phase is reached when strength may be a diminishing return with further increases in hardness values.

Brinell hardness (or any method of measuring hardness) does not necessarily indicate the ability of a metal to withstand abrasion or its resistance to wear, or the machining properties. Copper and aluminium are, compared with cast iron, relatively soft, and have low hardness values, yet such metals machine with some difficulty. The same Brinell numbers can, therefore, be obtained in two metals or alloys, but with altogether different machinability. Nor does high strength necessarily confer a high resistance to wear. From this it can be inferred that the structure has more comparative effect on machinability and wear than hardness.

The approximate specific gravities of various "metals" used in the cast metals industry will be of interest:—

Ferrous.		*Non-Ferrous.*	
Steel	7.90	Lead	11.35
Pure Iron	7.84	Bismuth	9.20
White Cast Iron	7.60	Nickel	8.80
Mall. Pig Iron	7.55	Copper	8.60
Close-grain Cast Iron	7.35	Tin	7.20
Average Grey Iron	7.15	Zinc	7.10
Soft Cast Iron	6.90	Antimony	6.70
Molten Cast Iron of Grey Iron composition	7.00 to 7.40*	Aluminium	2.56
		Magnesium	1.74

* Author's estimate. Reason for deduction to be stated in body of Paper.

Density and soundness can be influenced and controlled by the elements composing the alloy, melting practice, pouring temperature, mould materials and moulding technique.

Porosity or cavity which can be directly attributed to the ordinary metal composition can be readily dealt with in the light of modern metallurgical knowledge, but of equal or greater importance is the treatment of these easily-obtained alloy mixtures during melting and manufacture into castings of various shapes and section.

* A Paper presented to the Association Technique de Fonderie, on behalf of the Institute of British Foundrymen.

When deciding on a mixture for an alloy, consideration must be given to the practicability of producing the metal commercially and competitively, because, whilst an alloy may be admitted to be an ideal material for a particular casting, such metal may be expensive to produce, due to initial cost of the alloy and hazards of manufacture, particularly in the foundry, and also in the engineering departments.

The density of an alloy can be determined theoretically by calculation from the specific gravity of the respective metals, non-metals and metalloids composing the alloy, but such determinations can rarely be correct, since metal densities are so much influenced by gases, pouring temperatures and speed of pouring, especially in alloys of the bronze series and aluminium. Again, the density of certain alloys may be greater or less than the mean of the metals and elements composing the alloy.

General porosity can be materially reduced by employing dense metals and control of pouring temperature. Metals and alloys of a short freezing range tend to produce denser metal than those of longer solidifying-range, but whilst metals of short freezing-range give greater freedom from general porosity, there is greater risk in such metal of actual cavity and blow-holes if due regard is not paid to the provision of adequate feeder heads and the condition of the mould materials.

The freezing range of an alloy is determined by the components or elements in the alloy which affects the latent heat of fusion, superheat above melting point, final pouring temperature, section or mass in a casting and the state of the mould materials. All metals, with two or three exceptions, shrink in volume when solidifying from the molten condition, and there is a definite relationship between composition and shrinkage. Most metals undergo slight, and, in certain cases, considerable volume changes at the point of solidification and at some stage after solidification.

Volume Changes of Grey Iron

Grey cast iron, which is by far the most commonly employed of commercial metals, is of outstanding interest. The considerable volume changes in solidifying and cooling grey cast iron is responsible for imparting to the metal the reputation of the easiest of metals to cast, hence its employment in 90 per cent. of all casting requirements.

Grey iron is a complex alloy of metals and non-metals and metalloids, and is made up of 90 per cent. or more of iron compounded with impurities—carbon, silicon, phosphorus, manganese, sulphur, etc. Such compounds occupy in the metal considerable volumes. A pig-iron containing 6½ to 7 per cent. of impurities holds by volume 36 to 38 per cent. of compounds formed from such impurities. All the elements have, therefore, positive reactions with iron and each other.

The considerable volume changes in grey iron are mainly due to the swelling action of precipitated graphite on the dissociation of primary and secondary carbides from solution. The quantity and condition of the carbon is influenced, principally, by the presence of silicon, and to a lesser degree by the other elements contained in the metal, origin and mode of manufacturing the virgin metal, temperature of melting in the cupola, cooling or freezing rate as influenced by pouring speed and temperature, mass or section of metal in the casting and general condition of mould and mould materials. Fluid shrinkage and also linear contraction increase with an increase in combined carbon, since the lower the combined carbon the lower will be the volume change on solidification.

It is probable that grey iron expands during freezing from 5 to 8 per cent. Carbide has a density of 5.5 and graphite 2.0. The enormous expansion consequent on the precipitation of graphite from cementite or carbide neutralises very largely liquid shrinkage. The amount of expansion will depend on the analysis, original density of the metal and the original condition of the carbides, and the effect of the subsequent cooling range-time and temperature. The size of the crystals will also vary with the speed of solidification.

Influence of Occluded Gases

It is obvious that the density and soundness of grey-iron castings depend, primarily, on the amount and condition of the carbon. This aspect has been exhaustively probed, and is very conclusive so far, but much work requires to be done on the effect of both dissolved gases held in solution, or freed during freezing, and the influence of mould gases interacting with such occluded gases and the mechanical presence of same in the metal section.

The evolution of gas from the molten runner and riser gates and feeder heads in both ferrous and non-ferrous castings is a common phenomenon in the foundry. The freezing range of a metal will influence the amount, and also the condition, of gases retained in solution with the metal and the quantity freed from solution. Gases, when passing out of solution, will cause an increase in the volume occupied by the metal, unless completely freed from the melt. Carbon precipitation will tend to favour the release of gas from solution. Therefore, the chemical and physical reactions as a result of carbon changes and gas release probably provide the expansive and growth propensities of grey iron. The orthodox chemical analysis of metals may be misleading, and does not convey the whole story of metal. Analysis may indicate the amount of an element, but not its condition. For instance, graphite exists in cast iron in many different forms, and is described variously as flaky, nodular, curly and sooty, etc. The amount of carbon may be the same, but there is a wide difference between the strength and wear qualities, etc., of metal containing flake graphite and sooty graphite. Again, except experimentally, no account is given of the amount and condition of absorbed or dissolved gases. There is evidence that gas-free iron resists growth more effectively than metal with normal gas content.

The solubility of gases in metals increases with a rise in temperature. Prof. Piwowarsky has shown that highly-superheated cast iron of certain composition can be made to solidify white, whereas when melted at normal temperatures, a grey iron is obtained. Is it possible that, apart from the probability of a greater solution of graphite into the melt at very elevated temperatures that the greater absorption of gas at higher temperature favours increased pressures in the solidifying metal? Gas may act, as does the pressure of precipitated graphite, in producing patches of white iron in various sections of cast iron of certain composition which, by all ordinary analytical and physical reasoning, should solidify completely grey across the section.

Pointers from Blow-Holes

The examination of many types of mould and core blow-holes very often reveals a chilled skin on the face of the cavity. It is possible that steam blowing into metal would tend to absorb heat—be endothermic—and directly chill the blown metal, yet again the greater pressure set up by the evolution of gas may be a contributory factor in creating the chilled skin. On the other hand, most blow-holes and cavities have

the appearance of having been the centres of delayed solidification. It is again probable that the interaction of possibly occluded and mould gases will be exothermic and create an increase in local temperature.

Carbon monoxide is present in cast iron. Carbon monoxide is directly oxidised by steam at high temperatures. Interaction between carbon monoxide and water vapour takes place at 1,200 to 1,250 deg. C. Carbon monoxide burns in moist air with a pale-blue flame, but such a flame is extinguished when it is plunged into dry air. It is also known that other substances capable of forming water vapour by combustion, such as hydrogen, sulphuretted hydrogen and hydrocarbons, promote the combustion of carbon monoxide. The action of water vapour is partly catalytic, according to Armstrong, who states that two gases, which are inert in the pure state, require "the formation of a conducting system in which electrolysis can occur." Or, according to a later exposition by Armstrong, oxidation takes place "in a circuit composed of the oxidisable substance—conducting water and oxygen."

It will be evident that it is impossible to state definitely that the water vapour and the various gases evolved from mould and core materials are wholly endothermic or exothermic, but observation in the foundry inclines the author to the belief that the reaction of mould gases with metal gases is mainly exothermic. Such reactions will tend to favour further release of metal gases from solution. An acceleration of cooling reduces segregation of certain elements and also release of gases.

The growth and expansive forces in grey iron will be created by deposition of graphite, deposit of other impurities as films around the crystal grains, the building up of the crystal structure itself and pressure of dissolved gases. The phenomenon of solid grey iron floating on the surface of a bath of molten iron of grey-iron composition is conclusive proof that solid grey iron is of lower density than molten iron of a greying constitution.

Dissolved Gases in Steel

The effect of dissolved gases on a comparatively purer iron-steel is very remarkable. When producing steel ingots, generally, there are three classes of metal produced by controlling the gas content. The steels made are stated to be fully or completely piped, balanced and ebullient. The fully piping steel solidifies in the mould with little release of gas. It is very free from blow-holes, but contains a large pipe or cavity, or series of pipes in the upper central portion of the ingot. To reduce this cavity hot feeder heads are provided.

The midway or balanced type of steel is produced by pouring the metal into the mould in such a way that much gas is not released until the temperature of the metal in the mould has been reduced and sets early. The top of the ingot crusts over and, although gases can be seen breaking through the surface, the general evolution of the confined gases has the effect of reducing the amount of piping of the ingot.

The ebullient steel, or running steel as it is termed, ebulates considerably during freezing. Along with the freezing envelope of metal in contact with the mould, the solidification of the top of the metal is accelerated by closing down on the surface a heavy steel plate, which prevents the release of gas. This class of steel shows little apparent piping.

Each class of steel is controlled by pouring speeds and the employment of added elements which influence the solubility of gases in the metal. The most commonly-used elements are silicon, titanium and aluminium. The amount of the added elements introduced into the steel controls the quantity of gas held in solution, and if sufficient material is introduced the great bulk of gas is retained in solution.

There are processes for subjecting molten steel and other metals to mechanical pressure during freezing. Huge volumes of gas are given off during the pressure stage. Cast-steel castings, however, undergo little volume change on solidification to compensate for liquid shrinkage, as in the case of cast iron when carbon is precipitated from solution, consequently, liquid shrinkage is considerable and heavy feeder heads are employed on castings.

Malleable Cast Iron

Of the ferrous metals, white cast iron for malleable castings follows closely on the heels of steel in the order of liquid shrinkage. Although the solidifying metal undergoes a certain amount of volume change during the freezing stages, due to the presence in the iron of greater quantities of impurities, *i.e.*, combined carbon and traces of graphite, liquid shrinkage is again very considerable, compelling the use of heavy feeder heads, but not so heavy as for steel.

When making patterns for malleable iron, it is the practice to allow only very slightly more contraction allowance than for cast iron. In the hard state, before malleabilising, the castings contract very closely to that of steel, but during malleabilising—annealing process—the castings grow in volume. This growth in the solid state is due to the volume change consequent on dissociation of cementite into temper graphite.

The growth propensities of grey cast iron, if subjected to extended temperatures and repeated heating, is startling. The author has had cast-iron test-bars which have grown in volume by 25 per cent. after being subjected to repeated heating in the malleable-iron annealing ovens. The grey-iron bars were passed through three of the annealing cycles as practised for the Reaumur malleable-iron process.

Liquid Shrinkage and Gas in Ordinary Grey Iron

The effect of gases on steel is very obvious, and to a smaller extent in malleable iron. The influence is not so clear in the case of grey iron containing large quantities of impurities. In the foundry, with the exception of certain types of castings made by the centrifugal process and die castings, castings are made in sand.

When graphite is precipitated, considerable pressure is set up within the metal, much of which pressure and growth expends itself on the fluid interior as the metal cools layer by layer, but also much of this swelling action is exerted outward, and distention of the solidifying envelope takes place at several temperature stages. Sand moulds respond to this external pressure, and at some critical stage, depending on the composition and cooling rate, the casting is larger than the containing sand mould. This envelope, or shell expansion, can be largely controlled experimentally and in convenient classes of castings commercially.

The stronger and more resistant the mould, along with acceleration of the heat abstraction by the thermal conductivity of the mould materials and reduction of mould gases, the sounder and more dense the resultant casting. This hypothesis is especially applicable to grey cast iron, but it is also tenable in a smaller degree to any cast metals.

In a Paper delivered to the Institute of British Foundrymen in 1921, the author demonstrated that castings were the most unsound, and with the lowest density, when poured into green-sand moulds—this does not refer to very thin castings—sounder and more dense when poured into dry-sand moulds, still sounder and more dense when cast into loam moulds, and, when poured into a dried ganister or metal mould, there was an almost complete absence of liquid shrinkage.

(To be continued.)

THE UNITED ENGINEERING FOUNDRY COMPANY, of Youngstown, is shipping six stands of two-high hot mills and six stands of two-high cold-roll tinplate mills, with rolls and other equipment, to Japan for the new tinplate mill now under erection.

Ferrous Metals at the A.S.T.M. Annual Meeting

One complete session of the Thirty-seventh Annual Meeting of the American Society for Testing Materials, held in Atlantic City from June 25 to 29, was devoted to presentation of Papers and committee reports on ferrous metals and there were a number of other items of particular interest to this field.

The results of an extensive investigation of the effect of size and shape of test specimens upon the tensile strength, elongation in 2-in. gauge length and reduction of area of structural steel were given in a Paper by Messrs. Lyse and Keyser of Lehigh University. The specimens varied from ¼ to 1-in. diameter bars and from ¼ by ¼ to 1 by 4-in. rectangular sections which were machined from ¼-in., ½-in. and 1-in. thick plates from the same heat of structural steel. The authors conclude that size and shape of test specimens had practically no effect upon Johnson's limit or tensile strength, while elongation in 2-in. increased with the size of the specimen. Reduction of area decreased with an increase in the ratio of width to thickness of the rectangular specimens, but was nearly constant for bars of different diameters.

The Joint Committee on Investigation of the Effect of Phosphorus and Sulphur in Steel summarised the results of laboratory tests of four heats of low-carbon steel of progressively increasing phosphorus content. This is of importance due to the commercial practice of rephosphorising in the manufacture of welded steel pipe. Phosphorus contents were respectively 0.007, 0.051, 0.060, 0.080 per cent. Tests showed an increase in tensile strength and elongation with increase in sulphur content, but the proportional limit and reduction of area did not establish such relationship. Within the limits of phosphorus content used, the steels were not adversely affected in cold bending in the as-received or annealed condition, but an adverse effect was noted in the quenched condition. A very satisfactory degree of uniformity was noted between tensile properties determined longitudinally and transversely to the direction of rolling.

Two Papers presented at the meeting involved corrosion of ferrous materials. K. H. Logan, Chief, Underground Corrosion Section, National Bureau of Standards, discussed "The Use of Bureau of Standards Soil Corrosion Data in the Design and Protection of Pipe Lines." He mentioned that soils control to a large extent the corrosion of existing pipe lines. While the work has brought to light many new and useful facts, further work is required to determine the significance of certain tendencies shown by the data, notably the effects of size and age of the specimens on which pitting measurements were made, the protective effects of corrosion products and the results of departure from homogeneity of the soil with respect to its physical characteristics.

AMONG ORDERS recently secured by the companies in the Associated Electrical Industries group are the following:—The British Thomson-Houston Company, Limited: Sheffield Corporation, for Neepsend generating station, 30,000-kw. 11,000-volt turbo-alternator set, with condensing plant and accessories; Coventry Corporation, for the Longford power station, 33,000-volt three-phase metal-clad switchgear; Brisbane City Council, for the New Farm power house, 11,000-volt switchgear; East Rand Proprietary Mines, two electric winder equipments. Metropolitan-Vickers Electrical Company, Limited: Coventry Corporation, for Sandy Lane generating station and sub-station, 33,000-volt switchgear extensions; Southern Railway, instructions received to proceed with the manufacture of further electric coach equipment for the Eastbourne-Sevenoaks extension.

The Rôle of Box Parts in Quantity Production

Much has been said and written on the subject of mechanisation of the foundry, but it is very doubtful if complete mechanisation in the sense of automatic production of castings will or ever could come about. What is much more certain is that some foundries, not only in America but also in this country, are already suffering from over-mechanisation. On the other hand, some of the most prominent quantity-production foundries in this country have, perhaps wisely, completed their mechanisation, if such expression be permissible, by rounding off their sand-handling and moulding-machine equipment with one or two simple, cheap gravity conveyors.

As is well known, castings are being made by hand to-day at production figures which no moulding machine can approach. Railway chairs provide a case in point. Flushing cisterns are probably another.

Where, then, it might be asked, if mechanisation is a chimera and we cannot look for anything so spectacular to help us, are we to seek that improvement in efficiency of which the great bulk of the foundries are in need?

It is to the less-discussed but more significant details that we must look for help in this direction, and perhaps chief among these details is the moulding box.

In schemes for developing new foundries or for reorganising existing ones, the matter of the correct design and size of moulding box is usually given very little consideration until all other component parts of the equipment have been decided upon or ordered. Thus, the sizes of the boxes and their method of operation are evolved more often than not to suit the requirements of a particular moulding machine or some preconceived ideas on handling, rather than to suit the pattern to be accommodated or the type of casting to be produced. This fact may, and often does, have important bearing on the ultimate production figures. It is true that the modern moulding machine is more elastic as to the *size* of box that may be worked; but when considering the *type* of machine to be adopted it is a good plan to devote some thought and study beforehand to designing the most economical form of box equipment.

Let us consider, then, the necessary features and the possible variants which ought to be taken into account. The modern moulding box should be thought of and treated as a precision tool, which indeed it is. The accuracy with which castings have to be produced to-day is such that only an absolutely true parting face and perfect location between cope and drag is permissible. Yet it is a tool which is used under very adverse conditions of sand, heat and rough usage. For this reason it is a mistake to have too many locating pins on the boxes. There are some foundrymen who still feel that four pins make for greater accuracy than two, but this is not so, and except for long, narrow boxes, 6 ft. long or over, or where the end of the box is required for prints or pouring holes, two pins are a better engineering job and give just as good accuracy. In fact, the tendency is towards the "hole and slot" idea, in which the actual location is effected by one pin only at one end of the box, the second pin at the opposite end being used in an accurate slot. This prevents all possibility of binding on the pins and also allows the box to expand or contract without upsetting the pin centres. It is a system which has been adopted with marked success by several foundries, including one of the largest motor foundries in this country.

Fig. 1.—Sterling Boxes applied to the Production of Malleable-Iron Castings.

Fixed or Loose Pins

Whether pins are to be fixed or loose is a question which can be determined almost directly from a careful examination of the castings to be produced. Loose pins are always preferable on any completely new equipment, especially on symmetrical patternwork. But where methods of moulding or mould-handling are already established, fixed pins may have to be adopted. The hole-and-slot idea already referred to should be used in combination with loose pins to be really effective, or else the pattern plate must be slotted at one end.

Lightness is another cardinal virtue, and it is possibly the main reason why the rolled-steel box has made such headway in production foundries during the last ten years. The early steel boxes were made of sheet metal, sometimes corrugated in an effort to give an appearance of rigidity, which, however, was a quality conspicuous by its absence; and it was not until the Sterling Company, of Bedford, introduced the rolled-steel box of the solid-ribbed construction some ten or twelve years ago that any very definite large-scale progress was made in this direction.

For larger work much of the moulder's time may be saved by an intelligent prior study of the pattern to be worked, and by fitting the boxes with a suitable arrangement of cut-out bars which will "lift" without sprigging or gaggering.

Boxless Moulding Machines

The boxless machine is a very attractive-sounding proposition which some years ago found favour in a few large foundries in England. Its limitation lies in two facts—a larger proportion of sand is required for a given weight of castings in a mould, or, conversely, a smaller weight of castings can be produced in a given space; and secondly, the complete mould, consisting of both cope and drag portions together, has to be carried down from machine to floor, which means that two operators are necessary to handle this weight, and the final speed of production is slower than with boxes. It is not surprising, therefore, that many of these firms have reverted to boxes, mainly of the rolled-steel type.

Similar arguments apply to the use of snap flasks. Snap flasks sound very attractive for quantity-production purposes, especially on hand-operated machines, and they have been given a very extensive trial in almost all foundries engaged in the production of the smaller classes of castings. In a large number of malleable foundries in the Black Country the snap flask still reigns supreme, but the grey-iron foundries and the larger malleable foundries are rapidly discarding it in favour of the rolled-steel box. As an example of the benefit to be derived from such a change, one of the largest and best-known foundries in the Midlands decided to change over two machines from snap flasks to steel boxes.

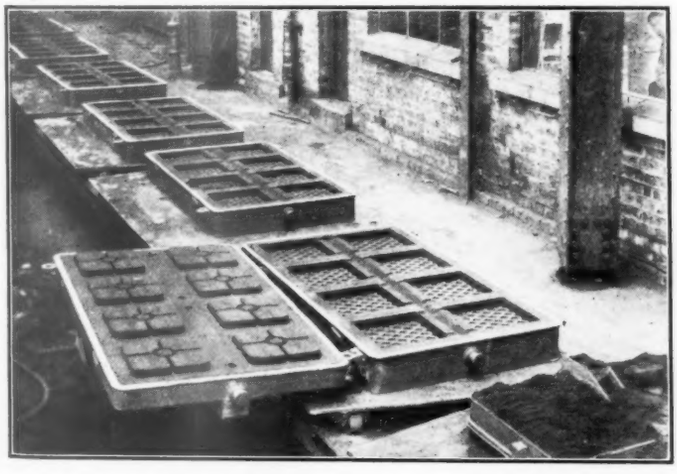

Fig. 2.—The Stanton Road Sett Mechanised Foundry resorted to specially-designed Sterling Boxes.

Fig. 3.—Showing the Boxes illustrated in Fig. 2 closed and being cast up.

The patterns were rearranged so that five castings per mould could be produced in the boxes instead of four in the snap flasks, and a new piece-rate was put into operation. In three weeks the men were working steadily, each putting down 135 moulds per day and pouring their own metal. The maximum with the snap flask was 100 moulds per day. In spite of the reduction in the piece-rate the men were actually earning more money, and the improvement in production paid for the box equipment in less than six months.

Whether the ideal moulding box will ever be evolved is a matter for some conjecture. Meanwhile, it is not too much to say that the rolled-steel box has made some revolutionary improvements in the production figures of some of the best-known quantity-production foundries in this country.

Anyone who has had an opportunity of visiting our principal foundries must have been struck by the frequency—we might almost say the certainty—with which the rolled-steel box is encountered. Some years ago this remark would have needed some qualification, for only the smaller types of steel boxes were employed on quantity-production work, but to-day we meet with steel boxes for making baths, aircraft and automobile cylinders, garden rollers, rain-water goods, and large steel castings in dry sand. The most recent development along this line is the great new Holwell plant of the Stanton Ironworks Company. This foundry was originally laid out for making pipe specials up to 6 in. dia., but has lately been fully engaged on the mass production of cast-iron road blocks, mainly for the Mersey Tunnel. Here the complete box equipment, including the pipe boxes and those for the road blocks, are the Sterling heavy-pattern rolled-steel boxes supplied by Sterling Foundry Specialties, Limited, of Bedford.

The great variety of types of present-day moulding equipment bewilders the average foundryman — plain jolt, jolt-squeeze, jolt-squeeze-roll-over, to mention only three. Which of this multitude is best for your job? The asking of this inevitable question is an all-sufficient reason for bringing us back to where we started. Study the job, think of the moulding and handling side of the problem, but do not leave the box equipment out of account until the last moment.

New Phase in Industrial Lighting

All who have driven or walked along the many arterial and suburban roads now lighted by the mercury-discharge system must have realised that this British invention is destined to play an important part in street lighting throughout the country—and is, indeed, doing so at this moment. But the use of discharge lamps is not confined to street lighting.

The General Electric Company now announces that they have completed arrangements for the successful application of "Osira" lamps to many forms of industrial illumination. Here it is probably safe to prophesy that its unsurpassed efficiency, its cheapness of operation, and its wide adaptability will win it success as swift and as dramatic as it has achieved in street lighting.

"Osira" industrial lighting is specially suitable for indoor and outdoor situations where a large area must be brightly and evenly lit. In foundries, steelworks, heavy engineering assembly shops and boiler shops, as well as for works, roads and car parks, the 400-watt "Osira" bulbs, each developing a light equal to a 1,000-watt gas-filled bulb, can be used to full advantage and with an enormous overall saving in current—or, more probably in these days of better lighting, to give an immense increase of light for the same cost as previously.

Effect of Slags upon Grey Cast Iron

The effect of slags with varying ferrous-oxide content upon the crystallisation, mechanical properties and gas content of cast iron containing 0.5 to 5 per cent. of silicon and up to 4 per cent. of carbon, has been investigated by P. Bardenheuer and A. Reinhardt.* A grey pig-iron containing 4.43 carbon, 1.5 silicon, 0.23 manganese, 0.044 phosphorus and 0.044 per cent. sulphur was used as raw material, to which steel scrap and 97 per cent. ferro-silicon was added to obtain the desired chemical composition. The melts were made in the high-frequency furnace at 1,500 to 1,600 deg. C. and treated with the following slags:—(1) After removing the melting slag, mill scale was fed on the bath in such a quantity that the slag, rich in FeO, which formed covered the surface of the bath completely. The melt remained under this slag for from 7 to 10 min. (2) After removing the first slag, the bath was treated with a mixture of mill scale and glass in the ratio of 1:1 for from 7 to 10 min. (3) After removing the second slag, glass was fed on the bath, and this slag was renewed several times. To eliminate the effect of superheating the sequence of the slags was varied. After each slag treatment three bars of 1.18 in. dia. and 27.8 in. in length were cast in dry-sand moulds. From some melts treated with glass slag further bars were cast whereby pulverised mill scale was strewn into the pouring jet. Of the test-bars the chemical composition as well as the oxygen and total gas content and the mechanical properties were determined. The structure was examined under the microscope.

After treatment with slags rich in FeO or feeding mill scale into the stream of liquid metal, solidification always takes place after the stable system without supercooling, whereas after treatment with glass slags low in ferrous oxide, the melts are more or less supercooled. In this case the hypoeutectic alloys with low carbon content show a well-defined dendritic structure with cementite inclusions and fine graphite. The alloys which solidified without supercooling exhibit a purely pearlitic groundmass with irregularly-distributed, somewhat coarse graphite. With normal solidification the graphite of the eutectic appears in the form of small flakes, which are the larger, as the carbon content becomes higher. In supercooled melts the eutectic graphite is present as finely-divided grains, the fineness of which increases with increasing degree of supercooling and decreasing carbon content. The primary graphite in hypereutectic alloys rich in silicon is present as very large flakes when solidification takes place after supercooling, and as smaller flakes when solidification is normal. In all the irons, however, which solidified without supercooling the groundmass consisted of pure pearlite, even in melts with a very high silicon content where the tendency of the solid solution to decompose is very great.

The different structures resulting from the slag treatment affect the mechanical properties. In hypoeutectic alloys with lower carbon content, treatment with glass slag brings about a heavy decrease in the tensile and tranverse strength, irrespective of the silicon content. The maximum decrease was found to be about 29 per cent. of the transverse strength and about 50 per cent. of the tensile strength. With increasing carbon content the difference in strength decreases and disappears at 3.4 per cent. of carbon. Above this figure an increase in strength results from the treatment with glass slag, the increase becoming greater with increasing carbon content. The deflection of the irons treated with glass slag was always lower. The tensile strength seems to have another critical range at 2.4 per cent. of carbon where it decreases rapidly. An effect of the slag treatment upon the Brinell hardness of hypoeutectic alloys could not be stated. In hypereutectic irons treatment with glass slag brings about an increase in strength at low-silicon contents, and a decrease at high-silicon contents. The Brinell hardness of irons low in silicon and rich in carbon is lower when treated with slag rich in FeO, but rapidly increases with increasing silicon and decreasing carbon content, and is then considerably higher than in irons treated with glass slag. The oxygen and total gas content of hypoeutectic irons is lower after treatment with glass slag. In hypereutectic irons a relationship between gas content and slag treatment could not be stated.

* Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Vol. 16 (1934), No. 6.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The last numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

16,801. WARD (WORCESTER), LIMITED, J., and HANSON, T. Metal strip blanking machines. 407,332.

20,209. INGERSOLL STEEL & DISC COMPANY. Process of making laminated metal. 407,362.

25,848. GÖTZ, R. Cageless roller bearings. 407,375.

25,993. FIRTH-STERLING STEEL COMPANY. Hard metal compositions. 407,395.

26,781. DURAFER, INC. Process of centrifugal casting and apparatus therefor. 407,413.

30,745. KLÜGER, L. Production of tubular articles of iron, steel, or metallic alloys. 407,444.

34,214. AKTIEBOLAGET BOFORS. Method of and means for producing hollow billets for hollow drills and the like. 407,472.

14,547. HASKINS PATENT PIPE LININGS, LIMITED. Method of lining metal pipes. 407,562.

22,494. PEYINGHAUS, W. Copper alloy with a comparatively high lead content, more particularly for rail-vehicle axle-journal brasses unprovided with soft metal liners. 407,609.

26,887. GRUBER, DR. K. Machines for straightening or smoothing metal members, particularly tubes and rods, in the cold state. 407,624.

27,679. JONES, E. F., and MAUSS, W. Apparatus for the production of hollow ingots. 408,013.

11,967. LINDE AIR PRODUCTS COMPANY. Methods of welding metal bodies, and pressure vessels having joints produced by such welding methods. 408,102.

18,485. THOMPSON, G. H. Tool for descaling tubes. 408,116.

26,725. I. G. FARBENINDUSTRIE AKT.-GES. Process of and mould for the production of metal castings of sound texture. 408,153.

32,193. GRUNTHAL, M. Apparatus for manufacturing seamless hollow bodies from solid billets. 408,179.

35,928. EUMUCO AKT.-GES. FUR MASCHINENBAU, and SCHNEIDER, A. Device for preventing the injurious effect due to heat expansion of the press housing in metal tube and bar stock extrusion presses. 408,187.

25,179. MUREX WELDING PROCESSES, LIMITED, and CLARKE, E. J. Welding of alloys, particularly alloy steels. 407,052.

26,565. COOPER, A. J. Machines for cleaning and polishing tinplates and the like. 407,103.

12,615. THORNTON, A. A. (Vereinigte Stahlwerke Akt.-Ges.). Connections for sheet-iron pilings. 407,211.

17,705. BRITISH THOMSON-HOUSTON COMPANY, LIMITED. Electric and other welding machines. 407,229.

19,473. SINGER, F. Matrix dies for extruding heated metals. 407,235.

21,155. BIRDSBORO STEEL FOUNDRY & MACHINE COMPANY. Crushers. 407,245.

20,769. WARD (WORCESTER), LIMITED, J., and HENSON, T. Wire or strip blanking machines. 406,306.

Silicosis and Sand-Blasting

The Annual Report of the Chief Inspector of Factories and Workshops for the year 1933 contains some extremely important information as to the incidence of silicosis amongst sand-blasters, as is disclosed by the following abstract.

Sand-blasting is essentially a method of cleansing surfaces by means of the forcible application of a stream of abrasive material. This is done usually (*a*) to alter or cleanse the surface prior to some subsequent operation, *e.g.* enamelling; (*b*) for the sake of the appearance produced on the surface so treated—a cleansing and finishing operation; and (*c*) to etch a design on the surface or to frost it, *e.g.*, on glass. Strictly, the term sand-blasting presupposes the use of sand as the abrasive, but not uncommonly it is used generically as applying to blasting with any form of abrasive. Almost invariably the abrasive is either sand, or chilled steel shot (termed grit or cornered shot), or a mixture of both materials. The term sand-blasting is here used to denote blasting with sand or a mixture of shot and sand as the abrasive, and the term shot-blasting, where the abrasive is metallic grit.

The abrasive is directed on to the article through a nozzle by means of compressed air at a pressure which may be varied within wide limits up to 100 lbs. per sq. in., but is commonly about 30 lbs.

The process is performed in a number of different ways:—(*a*) In the enclosed rotating-barrel type of apparatus; (*b*) in cabinets (in this method the operator standing outside inserts his arms through armholes with more or less tightly-fitting armlets and directs the stream of abrasive on to the article within the cabinet); (*c*) in chambers (in this case the operator stands within the special chamber or room, and is protected by a helmet supplied with fresh air under pressure); and (*d*) automatic apparatus of various kinds, which need not be described in detail. In every case an exhaust arrangement is fitted to the apparatus to collect the sand or other abrasive, which is then screened and re-used.

Incidence of Fatalities

In silicosis-producing industries, such as sand-blasting, where few are exposed to risk, the total number of deaths from silicosis in any particular year is small, and this may lead to the conclusion that the occupation is relatively safe when comparison is made with the numbers for other silicosis-producing industries. Further investigation, however, does not support this contention, as will be seen from examination of Tables I and II (not reproduced), which are compiled from particulars of 469 consecutive fatal cases of silicosis and of silicosis with tuberculosis of which full particulars are available. The cases are from a variety of silicosis-producing industries, and 37 of them were sand-blasters.

The tables show that the average duration of employment of sand-blasters who ultimately died from silicosis was 11.8 years, as compared with 34.4 years, the average duration of employment of all the fatal cases of silicosis irrespective of the causative occupation. For deaths from silicosis with tuberculosis, the average duration of employment in sand-blasters was 8.7 years, as compared with 31.5 years, for all the silicosis-producing occupations. Again, when the comparison is made with individual silicosis-producing industries, the invidious position of sand-blasting is apparent.

No other silicosis-producing industry shows such grave figures for the average working life-time of fatal cases, or figures comparable to the sand-blasting trade, except the manufacture of scouring powders, with figures of 11.1 years and 6.4 years respectively. As, however, the total recorded deaths from silicosis or silicosis with tuberculosis in the manufacture of scouring powders only amount to eight, one cannot say definitely that the risk in that trade is more than that associated with sand-blasting; moreover, the preventive measures extensively applied in the scouring-powder industry in the past few years have, no doubt, materially diminished the risk in that industry.

Dr. Merewether's Report

These considerations evidently demanded further inquiry, and therefore additional data were sought by particular investigation by Dr. Merewether, into the position in the Midlands, in which area sand-blasting is more particularly located. A synopsis of the findings of this investigation follows in the succeeding paragraphs.

In this area of the country there are only 272 factories in which there is blasting with sand shot, or mixtures of sand and shot. These factories employ 618 persons at this work. In 125 (45.9 per cent.) of the 272 factories there is still exposure to sand from the material used for blasting, and the number of persons engaged in these works on sand-blasting or blasting with mixtures of sand and shot is 264.

For practical purposes, therefore, of the 618 workers engaged on sand- or shot-blasting, 264 are exposed to sand, and therefore subject to a risk of contracting silicosis; in addition, there is the unknown, but presumably appreciable, although lesser in degree, risk of silicosis attendant on those workers engaged in shot-blasting metal castings to free them from adherent sand; this sand, of varying content of free silica, necessarily mixes with the shot; this risk is attendant on approximately 139 operatives employed in 117 out of the 147 factories doing shot-blasting only. Thus, in this area at the present time the minimum population at risk from the sand encountered in this work is 264, and the maximum is 403; the true maximum number may be a few more, as it is not possible to find out exactly the number exposed to the lesser risk in shot-blasting the sand from castings.

The population at risk is evidently very small, therefore, and although there has been a considerable change-over from sand-blasting to shot-blasting in the past few years, it is evident that this population at risk can never have been large, and presumably can never have exceeded the present total number of persons engaged in sand- and shot-blasting, *i.e.*, 618. Moreover, some firms have always shot-blasted and have never engaged in sand-blasting at all.

What the Statistics Show

It comes to this, therefore, that in this area during the period of exposure which has resulted in the deaths of sand-blasters from silicosis during the three and a-half years (1930-June, 1933), the population at risk must have been somewhere between 264 and 618; and it seems highly probable that the average between these two figures, *viz.*, 441, is, if anything, higher than the true figure.

The total number of deaths in the country from silicosis and silicosis with tuberculosis amongst sand-blasters which have come to the notice of the Department in the period under review is 38; of these 24 have been amongst sand-blasters employed in the area under consideration. In other words, out of a population of 441 or less, 24, or 5.4 per cent., have died from silicosis or silicosis with tuberculosis in the space of three and a-half years. This suggests a most serious risk, and even if the population at risk is taken as 618 (*i.e.*, the total number of sand- and shot-blasters, which number includes at least 200 shot-blasters on clean metal or other material who, so far as can be ascertained, do not come into contact with sand at all), even then 3.9 per cent. have died in three and a-half years.

Examination of the problem from the incontrovertible position of the verified deaths from silicosis or silicosis with tuberculosis in relation to the size of the group of sand-blasters amongst which these deaths have occurred points to the conclusion that sand-blasting is at present the most serious silicosis-producing risk in the country, although, of course, not the most extensive.

Underlying Causes

What are the causes underlying this situation? Essentially there must be an escape into the air of workrooms of considerable amounts of siliceous dust in a state of fine division to account for both the high death-rate and the short working lifetime. The abrasive sand used is, of course, of a highly siliceous nature, some being pure flint, and it is rapidly disintegrated into minute particles owing to repeated forcible impact on the articles being sand-blasted. This in itself is insufficient to account for the position, and therefore the methods of sand-blasting in use must be such as permit of the dissipation of much finely-particulate sand into the air breathed. In other words, there must be leakages from the cabinets, chambers or sand-collecting apparatus or into helmets worn by the operatives. It stands to reason that it must be a matter of extreme difficulty to confine within a particular space sand impelled by a pressure of anything up to 100 lbs. per sq. in. and shattered by impact, as ultimately it is, into the finest particles; furthermore, leakages are likely to be in quantity and with a high percentage of the finest and most dangerous particles.

Main Sources of Risk

When one considers that, according to some authoritative American observations,* the atmosphere in a sand-blasting chamber may contain up to 3,104 million particles per cub. ft., and that the general air of a workroom in which sand-blasting chambers are located may contain up to 118 million particles per cub. ft., one can appreciate the extent to which leakages can occur. How dangerous such leakages are is apparent when it is realised that a count of approximately one-tenth of the latter figure would involve a definite risk of silicosis. Naturally, a far greater risk attaches to operators working at or in close proximity to the sand-blasting plants. The main sources of risk may be summarised as follows:—

In the case of chambers using sand as the abrasive:—(1) The atmosphere inside the chamber is invariably dangerous during blasting and for a period afterwards; (2) the atmosphere inside the helmet, breathed by the worker, is invariably dangerous during blasting in the absence of an adequate positive fresh-air supply; (3) if the helmet is taken off and left in the chamber before the dust has settled, dust collects within it to a dangerous extent; and (4) the air in the workroom in which the sand-blasting chamber is situated may also be dangerous, due to leakages from the chamber and from various parts of the accessory plant and from opening the door before the dust has been removed by the fan.

The last statement applies also to cabinets and other forms of sand-blasting apparatus.

Shortly, the position appears to be that sand-blasting is essentially an extremely dangerous occupation, and while it may be possible with particular equipment, precautions, and constant supervision, to make it safe for the time, a breakdown in one direction or another is more liable to occur than in many of the dangerous

* "Sand and Metallic Abrasive Blasting as an Industrial Health Hazard." J. J. Bloomfield and L. Greenburg; J. Ind. Hyg., vol. xv., No. 4, pp. 184-204.

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trades, and the results of such a breakdown, even if only of a temporary nature, are most serious.

International Action Advocated

The risk of this process as disclosed led me to advise that the use of siliceous material should be prohibited except under special circumstances, when strict conditions of use should be required. The position was brought to the notice of the engineering employers through their federation, with a view to ascertaining to what extent substitutes for siliceous material can be used. Active steps were taken by the federation, and considerable progress has been made in the substitution of steel grit for siliceous material. There are undoubtedly certain types of articles which, at the present time, cannot be treated otherwise than by sand, but for the great majority of work steel grit can, I believe, be used. That different methods of working, and in particular careful grading of the pressures are necessary to get the same results, is undoubtedly the case, but these difficulties, to my mind, are not sufficiently great to justify the continuance of so grave a risk to health. When it can be shown that a substitute is absolutely impracticable, then the strictest requirements must be enforced, including initial and periodic medical examination of the workers. In this instance, as in others, we are handicapped by the competition of some other countries in which their advisers are still reluctant to recognise the danger of the inhalation of silica. It seems incredible that even now there are some who would deny the right of a workman to compensation for this defined and unmistakable disease of the lungs. In view of this attitude, the possibility of an international agreement on the lines indicated to safeguard the workers from the risk inherent in the process of sand-blasting seems very remote, but that it is necessary to protect the workers in all countries where sand-blasting is carried out I have no doubt.

Economic Conditions in France

"In 1933 over 50 per cent. of the manual workers in the French metallurgical industry as a whole were aliens." This is typical of the interesting information given by Sir Robert Cahill, C.M.G., Commercial Counsellor at His Majesty's Embassy, Paris, in his Report on the Economic Conditions in France which has just been published for the Department of Overseas Trade by H.M. Stationery Office at 7s. net. The book runs to 722 pages, and is particularly comprehensive. Whilst no particular section is devoted to the foundry industry, the author, who took a prominent part in the international foundry gathering at Paris in 1932, has borne the industry in mind and dealt with it wherever possible in the various sections. For instance, in Appendix 4, we are given the predominant earnings of a cupola man, an "aluminium" moulder and a patternmaker, but what fascinates us is that the patternmaker's earnings are set out in both "time" and "piece." Very few British firms have learnt how to pay patternmakers piece work. It matters not what section of the foundry industry in which one may be personally interested, one will find some portion of this Report, which runs to over 700 pages, informative as to the conditions now operating in France. The railways, shipping and textiles are all equally well covered.

A deputation from the Sheffield group of M.P.'s had an interview with the Minister of Transport recently, when they urged upon the Minister the advantages to be gained from the use of steel in the strengthening of weak bridges.

The Philadelphia Congress

Never in connection with any foundry congress has there been arranged such a wealth of works visits. It matters not in what section of the foundry industry the visitor may be interested, he still has a really wide choice of plants to inspect which are operating on his line of castings. About 40 are listed, but from what we know of our hosts' hospitality arrangements can be made to include others.

Below we give an annotated list of foundries which have been so kind as to open the works for inspection by the visitors:—

Buffalo

Bingham & Taylor Corporation.—Special grey-iron castings. 360 tons per week. Three 10-ton cupolas. Two electric furnaces.

Atlas Steel Casting Company.—Miscellaneous steel castings from ½ lb. to 10 tons. 650 tons per week. One 20-ton O.H. furnace and 1½-ton direct-arc electric furnace.

Pratt & Letchworth Company.—Open-hearth and electric steel castings, malleable-iron castings and forgings. Equipment includes an entirely synthetic sand-preparation unit. Furnaces are fired with powdered coal.

Otis Elevator Company.—Steel foundry. Two 6-ton electric furnaces. One 10-cwt. electric furnace. 500 tons per month, mostly of chrome-molybdenum and chrome-tungsten steels.

Jewell Steel & Malleable Company.—800 tons per month. Castings from 1 oz. to 200 lbs. Specialises in heat-resisting alloy castings.

Cleveland

Crucible Steel Casting Company.—Produces electric-steel castings and has six types of moulding equipment. Three electric furnaces.

Chandler & Price Company.

The Eberhard Manufacturing Company.—Typical malleable jobbing foundry. Noted for its expert careful moulding, the machining of many finished castings, and the plating and finishing of miscellaneous malleable parts.

Cleveland Co-operative Stove Company.

Forest City Foundries Company.

The Glauber Brass Manufacturing Company.—Typical jobbing brass foundry. Operates five gas-fired furnaces. Factory includes machine shop, assembly shop, plating and polishing departments.

The West Steel Casting Company.—Complete electric steel foundry. 400 tons per month. Two 1½-ton direct arc furnaces. Complete heat-treating and annealing departments.

Detroit and Vicinity

Bohn Aluminum & Brass Corporation.—Individual visits only.

Cadillac Motor Car Company. — Grey-iron, brass and aluminium foundries. Only American automobile foundry where cylinders are cast horizontally. Nickel used extensively in mixtures.

Chrysler Corporation (Foundry Division).

Chevrolet Grey Iron Foundry Division, General Motors Corporation, Saginaw. — Outstanding example of continuous-repetition work. Produces several hundred tons of grey-iron castings per day for Chevrolet company and other automobile plants of General Motors Corporation.

The Detroit Steel Casting Company.—Operates two types of foundry in one plant—one for light work, the other for heavy castings. The heavy shop operates two 20-ton oil-fired O.H. furnaces. Capacity: 700 tons per month. Light foundry employs ½-ton arc-type electric furnace Capacity: 250 to 300 tons per month. All castings are heat-treated. Complete chemical and physical laboratories, sand control, etc.

Detroit Grey Iron Foundry Company.

Ford Foundry—Rouge Works.—Greatest melting capacity of any grey-iron foundry in the United States. Blast-furnace and cupola metal mixed in 400-ton mixer, then superheated in 20-ton electric furnace. Alloy steel composition melted in cupola, treated in air furnace for new-style cast crankshaft. Intensive production methods.

Magnus Company, Incorporated.

Michigan Steel Casting Company. — Carbon- and alloy-steel castings, including special corrosion- and heat-resisting materials for general jobbing trade. 400 tons per month. Four direct-arc furnaces and one rocking-type indirect arc.

Packard Motor Car Company.

United States Radiator Corporation.—Average capacity: 60 tons per day, grey-iron castings; these include cast-iron boilers and one-part radiators for heating service. The one-part radiators are made in oil-bonded cores, assembled on a cast-iron fixture to produce the mould.

Dodge Bros. Corporation.—Produces about 3,000 cylinder blocks per day, with clutch housing, transmission, flywheel and other grey-iron parts. Capacity: 625 tons per day. Thoroughly modern foundry.

Saginaw Malleable-Iron Division, General Motors Corporation.—One of the largest malleable-iron foundries in the United States. Daily melting capacity in excess of 600 tons. Employs duplex method. Cupolas and electric furnaces.

Milwaukee and Vicinity

Harnischfeger Corporation.—Manufactures all types of handling equipment, including excavators, cranes, etc., also electrical equipment. Operates grey-iron, bronze, alloy and steel foundries. Outstanding example of modern practice in the manufacture of machinery of the type noted.

The Liberty Foundry, Incorporated.—General jobbing foundry, typical of Advanced American practice. Average daily capacity: 250 tons of castings, ranging from 2 to 40 lbs. in weight.

Milwaukee Steel Foundry.

Sivyer Steel Casting Company. — Two direct-arc electric furnaces. Example of jobbing foundry using production-shop methods. All castings electrically annealed. Very complete chemical and physical testing laboratory. Capacity: 850 to 900 tons of castings per month.

Spring City Foundry Company.—Light grey-iron foundry. 75 tons per day capacity. Automotive castings and jobbing work.

Belle City Malleable Iron Company, Racine, Wis., midway between Chicago and Milwaukee.—Produces malleable, steel and grey-iron castings. Tunnel kiln furnace employed for annealing. Part of the facilities of the steel department are utilised for producing special high-test grey iron.

Bucyrus-Erie Company.

Allis-Chalmers Manufacturing Company. — Devoted mainly to the production of heavy machinery castings up to 120 tons in weight. Unique type of hydraulic-pressure equipment for cleaning castings. Many castings are specially heat-treated.

Falk Corporation.—Steel foundry. Three 35-ton acid O.H. furnaces. 20,000 to 25,000 tons of steel castings per year. Outstanding example of cleanliness and good housekeeping. Employs complete sand-handling equipment and modern production machinery.

Motor Castings Company.

Pittsburgh

National Bearing Metals Corporation.

Pittsburgh Equitable Meter Company.

United Steel Casting Company.—Produces locomotive, railway-car, rolling-mill and large machinery castings from metal melted in one electric and two large oil-fired O.H. furnaces. Monthly capacity: 3,000 tons.

United Engineering & Foundry Company.—Produces some of the largest rolling-mill equipment in the United States. Castings from 5 lbs. to 100 tons in weight, in metal melted in three 34-ton O.H. gas-fired furnaces. Complete annealing equipment of pit and car type.

Core Prints

By T. R. Harris

One of the sure tests of a patternmaker's ability is displayed in the manner in which he "prints" his patterns. This and the successful production of coreboxes to suit shows his grasp of foundry technique in which he should be well versed. Unfortunately, one still finds patterns made with prints attached which reveal that the one responsible for their production was lacking in this necessary foundry knowledge.

As a rule, especially for dry-sand work, core prints should be made bigger than the corebox to allow for the expansion of the particles of sand on drying, and the coat of blacking given to both mould and core. For larger cores in which a cast-iron grid is used, the corebox should be made an amount smaller to permit of the expansion of the grid on drying of the core. For high-class and repetition work the coreboxes should always be shaped to the print to avoid filing of the core by the moulder before its insertion in the mould. The following examples, taken from recent practice, may serve to illustrate some of the principles of "printing."

Figs. 1, 2 and 3 illustrate portions of jobs which required a core, as at A, in each instance. Fig. 1 is a case in which the core is of large diameter and short, giving a very large surface on which to rest easily; consequently a shallow print will be suitable for this, being only required to locate the core in correct position. In Fig. 2 the core is of small diameter and long, and is not only required to be located, but held in position in the mould. To do this it is necessary to have a deep print so that the core can be firmly held upright by it. To use or not to use top prints is a question not fully understood by some, and they, to compensate for lack of knowledge, always play for safety and put one on. Top prints can become sources of trouble when closing a mould; however, in some cases they are indispensable to ensure the correct position of a core. In Fig. 2 a top print is not required, as the moulder can easily test the centrality of the core by the outside of the mould before closing. In Fig. 3 this is not possible, as most of the boss through which the core passes is in the top of the mould, the joint being along line BC. To ensure centrality of core it is necessary to place a print on top as shown. Fig. 4 shows an example many patternmakers would print on the back and carry the core in the top of the mould, which is needless expense. In this case a print for the core can be dispensed with; a flat core being made is placed in the mould on the two round bosses as shown. If the core is made $\frac{1}{16}$ in. shallow and the vent connected to the top, a layer of sand around it would be pressed tightly on closing and ensure of no metal entering the vent.

Fig. 5 shows another type of core print often referred to as a "core seat," it being jointed as the pattern, part in the bottom and part in the top boxes. When a job such as this is assembled, there is a danger of a "crush" taking place, to guard against which the moulder eases the top "seat" to clear the core. For repetition work this scraping of the mould should be unnecessary; the pattern should be printed to avoid this. The illustration shows a round seat with the top clearance. It must be remembered, when placing enlarged prints on a pattern, that it is only on the width and not depth that this clearance is required. If made with clearance on top, a "lift" of the core would result, throwing it out of centre. Distance A in Fig. 5 should be the same as distance B.

The next type of print is shown in Fig. 6 and is of the "Pocket" variety. A hole is required through a wall of metal which occupies a vertical position in the mould. To accomplish this a print is extended from the required position to the mould joint which allows of the insertion of the core. For one-off jobs a plain core would be made, inserted, and built over by the moulder, but for repetition work a core should be made which stops out the print portion as well. A shows the correct position of the print, the top of which touches the top box. If made as B and the moulder forgot to nail it to guard against "lift," it would float until touching the top box as shown in 6C.

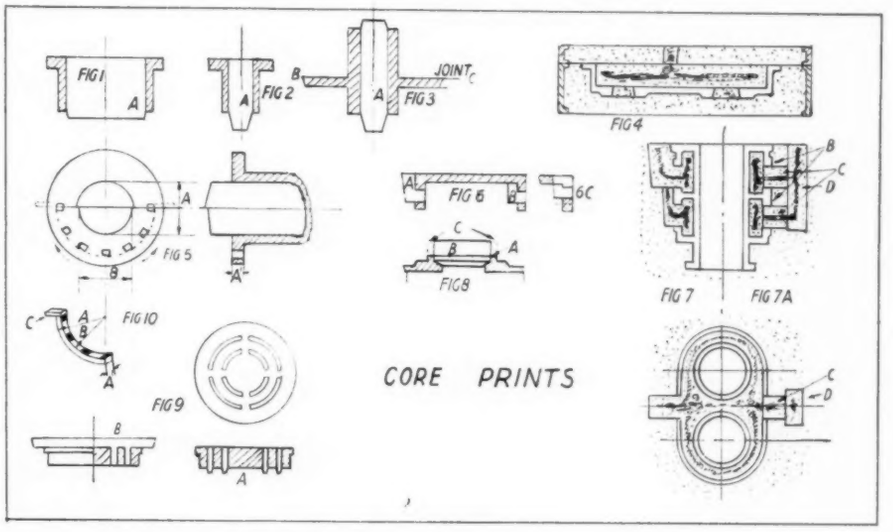
It reveals loose thinking on the part of the patternmaker who supplies a pattern printed as B when A could be readily used instead, and would save the moulder the trouble of nailing the core in position. Fig. 7 shows a cylinder water jacket kept in position by pocket prints. This arrangement unfortunately leaves a dirty mark on the casting which, although it does not detract from its usefulness, does cause it to be unsightly, which in high-class work has to be avoided. An alternative method of printing is shown in Fig. 7A, which, as Fig. 7, gives a section through the mould after the cores are assembled. On faces B are placed round prints the diameter of the holes cutting through as CC. These are about 3 in. long and are with the facings loose on the pattern, to be drawn in after the main pattern is withdrawn. When the mould is being prepared a piece of wood about 4 in. by 6 in. is rammed up in position as D, and is to provide a space for the moulder's hand, as will be explained later.

The jacket cores are made without any prints, but where the round ones will abut against them a $\frac{1}{2}$-in. hole is made in the side of the corebox, to bring the vents off. On assembly the round cores CC are first inserted and kept well back into the space D. The jacket core is now placed in on studs or chaplets and then cores CC are pushed forward until they are close up to the jacket core. This is accomplished by the moulder through space D, which space is now filled up, care being taken that the vents from the core are safely conducted to the mould joint.

Fig. 8 shows another type of problem, ridge A is required distinct and sharp as it is only $\frac{3}{16}$ in. wide and deep, and serves to keep a cover on this portion of a gear casing. When seats are placed on as at B and clearance allowed in the top box, invariably the scrap or fin of metal, occasioned by this clearance, causes difficulty in fettling to ensure the ridge as required. A better method is to print as C and carry the ridge in the core.

Fig. 9 illustrates a cast-iron valve seat which, when originally made, was printed as A for each core a separate print, which, needless to say, was a very wasteful method in assembling the cores, so much time and care had to be expended to ensure them being in a correct position, being upright, etc. The better way is shown at B, which consists of a top print of the overhang type, which embraces all the cores. These are all made in one box with the print, the job is then much simplified and improved.

Occasionally it may be better to dispense with prints and use templates for the insertion of cores, such a case would be the flange in Fig. 5. The bolt-hole cores, which are square, could be placed in pocket prints or by other methods sometimes adopted, but it will be found that the method about to be described is better. Two half-templates, as Fig. 10, are made, the diameter A being the outside diameter of the flange, while B is the same as the outside of the bolt holes, C being a piece to make the joint. This template being yellow varnished, the position of the holes are indicated in black, as Fig. 10. The method of using is to insert both in one-half flange, as dotted lines in Fig. 5, and on each of the black marks place a square core of the required size and length A[1] previously made from a core box, a nail into the side of the mould over each core and the job is done. The two half-templates can now be extracted by sliding over the face of the flange as indicated by the arrows in Fig. 5.



Figs. 1 to 10.—Types of Core Prints and Methods of "Printing."

Company Meeting

W. & T. Avery, Limited

The annual meeting of Messrs. W. & T. Avery, Limited, was held in Birmingham recently. Sir J. Fortescue Flannery, Bt. (chairman of the company), who presided, said that trading at home had shown a general and continuous improvement since about the middle of their financial year. They had been consistently carrying on important mechanical and scientific developments in weighing, counting and testing machinery. These developments were contributing in no small measure to the increased trade they were now enjoying. In certain directions they had experienced some improvement in overseas business, but in some other foreign countries it was still proving impossible to operate without losses.

Iron and Steel Institute

AUTUMN MEETING IN BELGIUM AND LUXEMBURG, SEPTEMBER 10–14

The Autumn Meeting of the Iron and Steel Institute, as previously announced, will be held in Belgium and Luxemburg, by the kind invitation of the industrialists of those countries, on September 10 to 14. Influential reception committees have been formed, under the Presidency of *M.* Léon Greiner in Belgium and *M.* Aloyse Meyer in Luxemburg; *M.* Auguste Greiner has kindly consented to act as honorary secretary of the Belgian Committee and *M.* Arthur Kipgen has kindly undertaken to carry out the arrangements of the programme in Luxemburg.

Two morning sessions (Monday and Tuesday, September 10 and 11), will be held in the Palais des Académies at Brussels for the reading and discussion of Papers, the afternoons being devoted to visiting works and places of interest in and around the city of Brussels, the Charleroi district and elsewhere. On the evening of Monday, September 10, a banquet will be offered to the visitors by the Groupement des Hauts-Fourneaux et Aciéries Belges, which is to be followed by a Reception at the Hôtel de Ville by invitation of *M.* le Bourgmestre Adolphe Max and the aldermen and councillors of the city of Brussels.

On Wednesday, September 12, the party will leave Brussels, travelling to Liége, where an inspection will be made of the works in the district. The visitors have been invited to luncheon by *M.* Léon Greiner and the Soc. Anon. John Cockerill, and to tea by *M.* Jacques Van Hoegaerden and the Soc. Anon. d'Ougrée-Marihaye. In the evening the party will proceed to Luxemburg. On Thursday, September 13, the party will be officially received by the Luxemburg industrialists, and the day will be spent in visiting the important iron and steel works in the district, the visitors being invited to lunch and tea by the companies whose works are visited. In the evening, the party are invited to a banquet by the Groupement des Industries Siderurgiques Luxembourgeoises, which will be followed by a ball by invitation of the Soc. Anon. des Aciéries Riunis de Burbach-Eich-Dudelange (Arbed). Friday, September 14, will be devoted to further visits to works and places of interest, lunch being taken in the country. A special programme of entertainments for the ladies has been arranged.

Itinerary

(*Subject to Revision*).

For members travelling from London, arrangements will be made with the Southern Railway Company to enable them to leave London (Victoria Station) by special train at about 14.45 on Saturday, September 8. The party will travel *via* Dover and Ostend to Brussels. It is presumed that members coming from other centres on the Continent will make their own travelling arrangements as far as Brussels.

For those travelling from London, the itinerary is as follows:—

SATURDAY, SEPTEMBER 8.

14.45.—Leave London (Victoria Station).

20.10.—Arrive Ostend. (Dinner will be served in the buffet at the Hôtel Terminus Maritime.)

21.45.—Leave Ostend.

23.15.—Arrive Brussels (Nord).

Programme

(*Subject to Revision*).

The programme prepared by the Belgian Reception Committee includes the following:—

SUNDAY, SEPTEMBER 9.

Afternoon.—An excursion around Brussels.

MONDAY, SEPTEMBER 10.

Official Opening of the Meeting.

Morning.—General meeting at the Palais des Académies. Reading and discussion of Papers.

Afternoon.—The following alternative excursions have been arranged:—(1) Soc. Anon. des Forges de Clabecq at Clabecq (composite iron and steel works entirely rebuilt since 1920); (2) Soc. Anon. des Cokeries du Brabant at Pont Brûlé and Usines de Fours à Coke et de Synthèse d'Ammoniaque du Groupe Coppée, at Willebroeck; (3) excursion to the Forêt de Soignies and the Château de Tervueren.

Evening.—A banquet will be given at the Palace Hotel by invitation of the Groupement des Hauts-Fourneaux et Aciéries Belges. Also there will be a reception at the Hôtel de Ville of Brussels, by invitation of *M.* le Bourgmestre Adolphe Max and the Aldermen and Councillors of the City of Brussels.

TUESDAY, SEPTEMBER 11.

Morning.—General meeting in the Palais des Académies. Reading and discussion of Papers continued.

Afternoon.—The following alternative excursions have been arranged:—(1) Les Verreries de Houdeng-Goegnies de la Soc. Anon. des Glaces et Verres (Glaver) (a modern plate-glass works of great interest) and Les Usines Gustave Boel at La Louvière; (2) Soc. Anon. Union des Aciéries, Charleroi (Bessemer-steel tyres, etc.) and Soc. Anon. des Forges de la Providence at Marchienne au Pont, near Charleroi; (3) visit to the historic Château de Gaesbeck and Maison d'Erasme at Anderlecht.

WEDNESDAY, SEPTEMBER 12.

Morning.—Departure by special train from the Gare du Nord for Liége; reception at the Château Cockerill. The following alternative visits to works of the Soc. Anon. John Cockerill have been arranged:—(1) Coke ovens, iron and steel works, etc.; (2) constructional and heavy engineering shops.

Afternoon.—The following alternative excursions have been arranged:—(1) Soc. Anon. d'Ougrée-Marihaye at Ougrée; (2) Soc. Anon. Safak at Sclessin-Ougrée; (3) Soc. des Tubes de la Meuse at Flémalle-Haute; (4) Fabrique Nationale d'Armes de Guerre at Liége-Herstal; (5) visit to the showrooms of the Cristalleries du Val. St.-Lambert.

Evening.—Departure by special train and arrival at Luxemburg.

The programme prepared by the Luxemburg Reception Committee is as follows:—

THURSDAY, SEPTEMBER 13.

Morning.—Welcome by *M.* Aloyse Meyer and the members of the Luxemburg Reception Committee at the Hôtel de l'Arbed (head offices of the Soc. Anon. de l'Arbed).

For those desirous of visiting works the following alternative visits have been arranged:—

Afternoon.—(1) Dudelange (Arbed) (iron and steel works); (2) Esch (Arbed) (iron and steel works); (3) Esch-Belval (Arbed, Terres Rouges) (iron and steel works); (4) Differdange (Hadir) (iron and steel works); (5) Rodange (Ougrée-Marihaye) (iron and steel works); (6) for those not visiting works, lunch will be available at the Hôtel de l'Arbed by invitation of the Soc. Anon. de l'Arbed, and visits will be made to places of interest in the City of Luxemburg.

Evening.—Banquet in the Hôtel du Cercle at Luxemburg, by invitation of the Groupement des Industries Siderurgiques Luxembourgeoises. Ball in the Hôtel de l'Arbed, by invitation of the Soc. Anon. de l'Arbed.

FRIDAY, SEPTEMBER 14.

Morning.—For those desirous of visiting works, the following alternative works visits have been arranged:—(1) Dudelange (Arbed); (2) Esch (Arbed); (3) Esch-Belval (Arbed, Terres Rouges); (4) Differdange (Hadir); (5) Rodange (Ougrée-Marihaye) (same as Thursday afternoon); (6) for those not taking part in the visits to the works an excursion to places of particular interest in the Grand Duchy has been arranged.

Afternoon.—The afternoon will be occupied by a further tour of the Grand Duchy in motor-coaches.

SATURDAY, SEPTEMBER 15.

Members will leave Luxemburg for the return journey.

Steel Castings in U.S. Rolling Stock

In the course of an article entitled "Car Underframes from Cast Steel," in a recent issue of "The Iron Age," MR. T. W. LIPPERT states that one of the largest and heaviest railroad castings ever made was the bed for a Union Pacific 4-12-2 type locomotive. The weight was about 37 tons, it was 64.25 ft. long, and practically all of the foundation below the cab line was incorporated in a single unit. While developing large one-piece beds, nearly all of which have been built with integral air tanks and cylinders, it was necessary for the foundry and machine departments to solve many complex moulding and finishing problems. Now when the castings leave the foundry they are completely machined and drilled with cylinder barrels and valve chambers completely bored and tested hydrostatically. Later beds also integrally embody the rear cylinder heads.

These cast-steel frames have all performed satisfactorily in service, and their use has resulted in lower operating costs arising from their light weight, greater strength and compactness. In addition, the unit construction reduces maintenance and repair costs. This may be illustrated by the fact that a general shaping of an engine with a one-piece frame often costs about $3,000 less than in the case of an engine with a built-up frame.

In addition to the flexibility of metal distribution, high-tensile strength and homogeneity of the metals, cast steel has a considerable resistance to corrosion which greatly extends the useful life of rolling stock. Open-hearth charges for this work consist principally of pig-iron and carefully-selected scrap, and a single heat may weigh up to 80 tons. The steel as poured has a carbon content between 0.15 and 0.20 per cent., and other elements analyse at not over 0.06 per cent. phosphorus and a negligible amount of sulphur. The physical properties range over 27 tons per sq. in. tensile strength, 14 tons per sq. in. yield point, 22 per cent. elongation in 2 in. with 30 per cent. reduction of area.

"Dopploy," a new Alloy Grey Iron

A new alloy grey iron has been marketed in the United States under the trade name "Dopploy." Enough nickel is put in the regular grey iron to impart to it the general characteristics of the austenitic irons, similar to "Ni-Resist." Besides its unusual resistance to the effect of heat and the degree to which it resists acids and alkalis, the new alloy also provides protection against discoloration or contamination of caustics and similar chemicals, since it contains no copper.

Endurance Strength of Cast and Welded Structural Parts

Comprehensive tests on cast and welded structural parts have been carried out by A. Thum and Th. Lipp.* The following questions had to be answered:—(1) whether the cast or the welded type of such parts is more durable when subjected to reversed bending or impact stresses; (2) what factors affect the endurance strength of structural parts, and (3) what means are available for increasing the endurance strength.

Endurance bending and impact tests were made by determining under a given load the number of stress reversals sustained until fracture occurred. The tests were made in specially-designed machines which are fully described in the original Paper. Details of the performance of the tests and the evaluation of the test values are also given. ⊥-shaped test-pieces of two different sizes were used cast as one-piece in grey iron and steel. The welded test-pieces made of mild steel with a tensile strength of 24.4 tons per sq. in., had the web welded to the flange by means of fillet welds made by the metal-arc welding process. In testing, the flange was firmly screwed to a base plate, and the stress acted upon the end of the web so that the critical section was at the transition from the web to the flange.

The small test-pieces had a web 10.6 in. long, 1.18 in. wide and 0.256 in. thick. Preliminary experiments showed that in testing structural parts the endurance basis of 10 million cycles, usually adopted for tests on round polished test-bars, is not sufficient to disclose the true endurance strength. Fractures occurred even after 60, 80 and 90 million cycles. To get the true endurance strength it is, therefore, necessary to extend the test to as large a number of cycles as possible. In the as-delivered state the welded test-pieces had an endurance bending strength of 7 to 7.6 tons per sq. in. At this stress, however, the S/N curve still shows a falling tendency. It is particularly the notches in the weld, sharp corners at the transition from the weld to the parent metal and, occasionally, the different height of the two fillet welds which decrease the strength. When these defects had been removed and a gradual transition from the web to the flange had been made, strength figures of 10.2 to 10.8 tons per sq. in. could be obtained. At the same time the scatter of the test values decreased and the S/N curve merged at the stress mentioned into a parallel to the abscissa (N axis). By dressing the weld the rigidity of the structural part is not affected. The endurance impact tests confirmed the results of the bending tests. All the test-pieces showed that from the appearance of the fracture conclusions can be drawn as to the number of cycles sustained; the smoother the fracture is, the higher is the endurance strength. The tests show that in welded structural parts, apart from very heavy defects, the shape and appearance of the weld is of greater importance than the microstructure. Since in practice, particularly in very large structures, dressing of the weld will not be economical, the authors recommend the use of ductile electrodes which give clinging welds without notches and craters.

The small cast-iron test-pieces were made of an iron having a tensile strength of 15.9 tons per sq. in. and the following composition:—carbon 3.2, silicon 3.14, manganese 0.78, phosphorus 0.5, and sulphur 0.4 per cent. In the as-delivered condition they had a rough irregular surface and showed an endurance bending strength of 8.3 to 8.9 tons per sq. in. The S/N curve of these pieces showed, as in the case of round polished test-bars, at first a steep slope and then turned after a sharp bend into a parallel to the abscissa. When a surface layer 0.004 to 0.008 in. thick, which consisted chiefly of silicates, had been removed, the S/N curve showed a flatter curvature and lay above that of the untreated pieces by about 1.3 tons per sq. in. The impact tests, too, gave a higher strength of the finished parts. This shows that cast iron of higher strength, which in the surface layers has a steel-like structure with fewer and finer graphite particles, is not so proof against the effect of surface defects as is generally assumed. Particularly good results were obtained with a special iron having a tensile strength of 20.3 tons per sq. in., and an extremely smooth surface. Test-pieces having a conical transition from the web to the flange had an endurance bending strength of 11.4 tons per sq. in., those with a sharp transition 8.9 tons per sq. in. The S/N curves showed a very flat curvature. This special iron proved very sensitive to surface defects. So, in one test-piece a minute blow-hole near the surface caused fracture to occur in a cross-section far removed from the critical section. The tests show that in cast-iron structural parts which are subjected to reversed stresses, great attention must be paid to the surface condition and the graphite near the skin. The tests on tee-pieces made of cast steel (tensile strength 29.8 tons per sq. in.) showed that the endurance strength of such parts is dependent on the surface finish of the casting in a still higher degree than in the case of cast iron. By smoothing the surface the strength can be increased but the scatter of the strength figures is still considerable. Apart from surface defects the microstructure affects the endurance strength. The finer the grain and the more regular the distribution of the pearlite-ferrite mixture is, the higher is the endurance strength. A burnt structure gives a laminated coarse-grained fracture and a low strength figure. Tests carried out on tee-pieces made of cast steel with a tensile strength of 38.1 tons per sq. in. showed that the endurance strength of the casting does not increase in the same proportion as the tensile strength, because the stronger steel has also a greater sensitiveness to surface defects.

In order to imitate conditions prevailing in practical service more closely, further endurance bending tests have been carried out on large tee-pieces having a web 17.7 in. long, 3.94 in. wide and 0.788 in. thick, with a correspondingly large flange. Since in practice engineering components are, in the majority of cases, pre-stressed by a static load to which comes an additional stress by temporary vibrations or shocks, tests were also made on pre-stressed parts. Because of the longer seam the large welded tee-pieces showed a lower endurance strength than the small pieces. By removing the notches in the weld the strength could be increased by about 15 per cent. The heavier wall-thickness caused the endurance strength of the large cast-iron tee-pieces to drop by 1.3 to 1.9 tons per sq. in. In spite of the coarser graphite flakes these parts still showed a certain sensitiveness to surface defects. The higher endurance strength of thin-walled castings as revealed by the tests on the small tee-pieces, should be an incentive to foundrymen to increase the competitive power of cast iron by lighter design. The tests on the large cast-steel parts showed, as did those on the small pieces, that the high strength of cast steel can only be made the best of, in a really sound casting with a high surface finish. However, high-tensile strength steels had about the same endurance strength as softer steels. Three wrought test-pieces showed the low endurance strength of 7.6 tons per sq. in. Because of surface defects and the small number of pieces tested, the results cannot be regarded as conclusive.

Table I.—*Endurance Bending Strength of Cast and Welded Tee-Pieces.*

1	2	3	4	5	6	7
Material.	Tensile strength of round test-bar.	Endurance bending strength of			Ratio Column 3 / Column 4	Endurance bending strength of small tee-piece.
		Round test-bar.	Large tee-piece.	Large tee-piece when pre-stressed.		
	Tons per sq. in.	Tons per sq. in.	Tons per sq. in.	Tons per sq. in.		Tons per sq. in.
Welded pieces (mild steel)	24.4	11.8				
Convex fillet weld ..			5.1	—	2.31	7.3
Concave fillet weld ..			5.7 to 6.4	8.3 ± 3.2	1.95	—
Notches removed ..			7 to 7.3	—	1.64	10.8
Cast iron—						
Defective	12.7	6.4	5.1 to 5.4	—	1.21	—
Normal	13.3	7.0	5.7 to 6.4	7.6 ± 3.2	1.16	8.3 to 8.9
Surface smoothed ..	—	—	—	—	—	8.9 to 9.5
Cast steel V.St. ..	29.8	13				
As-delivered			10.2 to 10.8	11.4 ± 8.9	1.24	10.8 to 11.4
Surface smoothed ..			c. 10.8	—	1.21	12.1 to 12.7
Cast steel W.A.I ..	23.5	11.1				
As-delivered			8.9 to 9.5	—	1.2	8.9 to 9.5
Surface smoothed ..			9.5 to 10.2	—	1.13	—
Cast steel W.A.II ..	40.6	15.9				
As-delivered			9.5 to 10.2	—	1.61	c. 11.4
Surface smoothed ..			9.5 to 10.2	—	1.61	—
Wrought pieces—						
As-delivered	23.2	12.1	7.6	—	1.59	—

The test results of the large tee-pieces are recorded in Table I. The strength figures of the small pieces are added for comparison. In column 6 the ratio endurance strength of round test-bar to endurance strength of tee-piece is given, which represents the coefficient of notch effect combining all the factors which decrease the endurance strength of structural parts. The figures show that the strength of the material is best utilised in the case of cast iron and cast steel of low and medium tensile strength.

* "Die Giesserei" 1934, Nos. 5-10 and 13-14.

The Cunard-White Star liner "Albertic" has been sold to Japanese shipbreakers for about £34,000. She is a twin-screw vessel of 18,940 tons gross. The price realised is the highest paid for a merchant ship for scrapping for a long time.

XUM

This Week's News in Brief

Trade Talk

The steel-screw and sea-going tug "Ray" was launched by Messrs. Alexander Hall & Company, Limited, Aberdeen, on Friday. The vessel will proceed to Hull for the L.N.E. Railway Company's service in that area.

The Fairfield Shipbuilding & Engineering Company, Limited, Glasgow, has received an order to build a paddle-steamer for the L.M.S. Railway Company for their Holy Loch service. The vessel will be 195 ft. in length and 27 ft. in breadth. The engines will be of the three-crank triple-expansion type.

The L.M.S. Railway Company announces that it has been decided to construct 117 new locomotives at the company's workshops at Crewe and Derby under the 1935 locomotive renewal programme. Crewe will construct 55 new engines and Derby 62. Ten engines are to be of the famous "Princess Royal" class.

The Treasury, on the recommendation of the Import Duties Advisory Committee, have issued the Import Duties (Drawback) (No. 15) Order, 1934 (S.R. & O., 1934, No. 846), authorising under Section 9 of the Finance Act, 1932, the continuance with slight modification of the scheme of drawback in respect of billets of steel used in the manufacture of hollow mining drill steel which was originally brought into operation a year ago.

World copper consumption, which has fallen continuously since 1929, showed a recovery last year, according to the annual report of the Union Miniere du Haut Katanga. In January, 1933, the Union's output of copper ore was 3,350 metric tons, which increased steadily to 7,000 tons by December. The total output for the year was 66,596 tons, as against 54,000 tons in 1932; ore stocks totalled 720,000 tons on December 31, 1933. New deposits are being slowly opened up.

The Harland Engineering Company, Limited, of Alloa, has added to its list of overseas orders by securing the contract for a new pumping station for the municipal waterworks at Riga, in spite of severe German competition. The total capacity of the pumping station will be about half-a-million gallons of water an hour and about 700 h.p. It is a considerable achievement to have secured this contract, as, until now, the Baltic States have mainly been supplied with plant from German sources.

What is claimed to be the largest electric motor ever built in Scotland has just been completed by Messrs. Bruce Peebles & Company, Limited, Edinburgh, for a flour mill in Montreal. The overall length of the motor is 20 ft. and its height is 15 ft., while the total weight is approximately 45 tons. It will exert a starting power of 7,500 h.p. Fabrication was adopted in the construction, and castings have been practically eliminated. The stationary part of the motor was built in halves to facilitate erection and transport. Transportation from Edinburgh to the Glasgow docks was effected by road on specially-designed trucks. The contract included three large transformers and a number of small transformers.

The turnover of the United-States Steel Corporation showed a big improvement in the June quarter. Net earnings amounted to $5,350,000, which compares with a loss of $6,989,965 in the preceding quarter and a loss of $8,627,367 in the corresponding quarter of 1933. A dividend of 50 cents has been declared on the preferred stock for the quarter. This is the same rate as had been paid for the six preceding quarters. Mr. Myron C. Taylor, chairman of the Corporation, announced that operations for the second quarter averaged the highest since the first quarter of 1931, at 48 per cent. of capacity, compared with 29 per cent. for the first quarter of 1934, and 27.5 per cent. for the second quarter of 1933. Net earnings for the second quarter were equal to $1.48 per preferred share. This is the first time since the third quarter of 1931 that anything has been earned for holders of the preferred stock, on which the cumulative arrears are now $8.75 per share.

Contracts for about 30,000 tons of merchant shipping were placed with Clyde yards during July, the figure being only slightly less than the output since the beginning of the year. It is unlikely, however, that the favourable ratio will be maintained during the remainder of the year. A number of large vessels are now in the final stages of construction, and a few, including the Cunarder, will take the water in August or September. Against this, there is the prospect of a share of the 1934 British Naval programme, tenders for which are already being prepared, while a number of orders for merchant ships are at present the subject of negotiation, and may be placed within the next few weeks. The position in the industry is regarded as fairly satisfactory, and now that the Glasgow Fair holidays are over, some new keels will be laid. It is confidently expected that there will be no diminution in employment during the autumn and winter months.

In Scottish industrial areas keen interest is being shown in the constitution of the local advisory board formed by Credit for Industry, Limited, the company which specialises in the provision of capital of a medium-term character to help the smaller industrialist. The board is under the chairmanship of Mr. J. Gibson Jarvie, who is also chairman of Credit for Industry, Limited, and of its parent company, United Dominions Trust, Limited. The other members are Sir A. Steven Bilsland, who is a director of the Union Bank of Scotland; the Earl of Elgin and Kincardine, a director of the Royal Bank of Scotland; Mr. W. T. Henderson, partner of Messrs. S. M. Penney & Macgeorge, Glasgow; Sir James Lithgow, chairman of Lithgows, Limited, Port Glasgow, and a former President of the Federation of British Industries. Mr. Norman W. Duthie, of Messrs. Mann, Judd, Gordon & Company, will act as secretary. The Scottish Advisory Board will work in co-operation with the Scottish National Development Council as far as possible, and will pay special attention to the industrial areas of the country.

Sir Godfrey Collins, the Secretary of State for Scotland, will officially open the new building of the Glasgow Trades School next month. The work of the trades classes has been carried on hitherto in the Stow College and a number of other buildings in the city, but when the new building, which is now almost completed, is opened, the work will be concentrated there. The new building, situated in Shamrock Street, in the Garnethill district, estimated to cost £120,000, has been fitted with the most up-to-date equipment for the instruction of apprentice tradesmen in a wide variety of technical subjects. The centre will provide instruction in about 20 different trades, and there will be art rooms, drawing offices and physical, chemical, engineering and research laboratories, as well as well-equipped workshops, including a forge, foundry, patternshops, welding and plumbing and other shops. Comprehensive courses are arranged for the various subjects, and students who desire to continue their studies further can pass from the school to the Royal Technical College. In the equipment of the foundry and patternshops the Education Committee of the Corporation have had the assistance of an advisory committee drawn from the Scottish Branch of the Institute of British Foundrymen. The foundry courses are arranged to comply with the requirements of the City and Guilds of London certificate courses.

Company Report

Warner & Company, Limited.—Profit, £6,486; brought in, £370; preference dividend, £2,058; directors' fees, £400; income tax, £648; final dividend on ordinary shares of 2½ per cent., making 5 per cent. for the year; depreciation (property, plant, etc.), £1,000; carried forward, £1,174.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Northern (King's Cross) Sheet Metal Company, Limited, 49 and 50, Twyford Street, N.1.—Capital £1,000 in £1 shares. Director: A. Giggs.

Metallic Productions, Limited.—Capital £100 in £1 shares. Directors: F. Bramhall, 6, Canterbury Drive, Sheffield 10; W. H. Curtis and L. Bramhall.

Deeley & Company, Limited, 346, Bell Barn Road, Birmingham.—Capital £500 in £1 shares. Sheet-metal workers. Directors: W. J. Deeley and Lydia F. Deeley.

Personal

Mr. S. C. E. Lloyd has been elected chairman of the Zinc Manufacturing Company, Limited.

Sir James Lithgow, Bart., chairman of Lithgows, Limited, Port Glasgow, has become chairman of the Steel Company of Scotland, Limited, and Mr. Peter Baxter, managing director of Messrs. James Dunlop & Company, Limited, and a director of Colvilles, Limited, has joined the board. These appointments follow the recent acquisition of the shares of the Steel Company of Scotland by Sir James Lithgow.

Mr. Cecil Clayton, Brooks, Phillips & Company, Limited, Paddington Green, W., has been elected chairman of the Auxiliary Committee of the Royal Metal Trades Pension and Benevolent Society on the resignation of Mr. T. S. G. Ramsey, who had occupied that position since 1921. During recent times the principal work of the Auxiliary Committee has been the provision of Christmas grants for the poorer pensioners, and the Committee has collected a sum of £5,752 for this purpose. In addition, the members have collectively been the means of introducing nearly 900 new subscribers to the Society, a splendid record.

Wills

Draper, T. A., for many years a director of Messrs. Wilsons & Mathiesons, Limited, ironfounders, of Armley, Leeds £34,696

Storr, W. W., of Cowfold, Sussex, late of Messrs. Bolckow, Vaughan & Company, Limited, iron and steel manufacturers £22,915

Edmunds, W. P., governing director of Messrs. Walter P. Edmunds, Limited, brass and iron founders, of King's Mill, Wednesbury £38,506

Palmer, Sir Frederick, of Messrs. Rendel, Palmer & Tritton, consulting engineers, President of the Institution of Civil Engineers, 1926-27 ... ... £166,504

Burkinshaw, Wilfred, governing director of W. Burkinshaw, Limited, steel tilters and forgers, Bath Steelworks, Penistone Road, Sheffield £15,255

Obituary

Mr. Charles Scott, who was managing director of Messrs. Scott & Hodgson, Limited, Guide Bridge Ironworks, near Manchester, for 40 years, retiring in 1925, has died in his 76th year.

Mr. William Hastings Bassett, the recently-elected President of the American Society for Testing Materials, died at his home in Cheshire, Conn., on July 21. Mr. Bassett, a pioneer metallurgist in the non-ferrous metal industry, and directly concerned with many of its technological advances, was metallurgical manager of the American Brass Company, Waterbury.

Many readers connected with the light-castings industry will regret to learn of the death of Mr. James Kidston, which occurred at the home of his daughter in Callander recently. Mr. Kidston, who left the Falkirk district about three years ago, had a notable record of service with the Falkirk Iron Company, extending to 65 years, and he was the proud possessor of a gold watch presented by the company, in 1918, to mark the celebration of 55 years' service. Mr. Kidston, who was 82 years of age, began work with the Falkirk Iron Company when he was eleven years of age, and retired in 1927.

Applications to Register Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

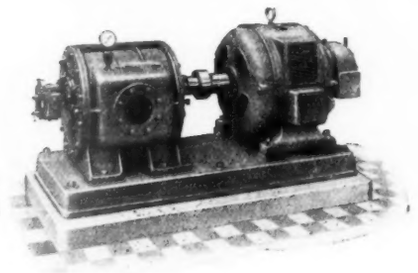
"Qualpriser."—Unwrought and partly-wrought metals. James Stansfield & Son, 38-40, Union Street, Bradford, Yorkshire.

"Lo-Ex."—Metallic alloys. Northern Aluminium Company, Limited, Bush House, Aldwych, London, W.C.2.

"Drakon."—Metal valves. S. Dixon & Son, Limited, 20, Swinegate, Leeds.

ROTARY COMPRESSORS

ROLLING DRUM TYPE.



"Reavell" Rotary compressors are made in eleven standard sizes with delivered capacities up to 2,000 cu. ft. free air per minute. They are made as air cooled machines for pressures up to 20 lbs. per sq. in., and are water jacketed for higher pressures.

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Raw Material Markets

The consumption of pig-iron is, of course, being considerably reduced during the holiday season, and producers are having to place iron in stock. Forward order-books are fairly well filled, however, and a strong resumption of buying is confidently anticipated once the holiday season is over. Similar remarks apply to the domestic section of the steel trade. A satisfactory feature is the recent improvement in the volume of export inquiries for British steel.

Pig-Iron

MIDDLESBROUGH.—The local demand for Cleveland foundry iron is limited by the usual seasonal influences, and a resumption of buying is not anticipated for two or three weeks. Foreign demand is also at a low ebb. However, the bulk of the ironmasters' August output is already sold, and, with an improving Scottish demand now that the Glasgow and Falkirk holidays are over, the situation is not unsatisfactory. The official prices for No. 3 Cleveland G.M.B. are 67s. 6d. per ton delivered Middlesbrough, 69s. 6d. delivered North-East Coast, 67s. 3d. delivered Falkirk and 70s. 3d. delivered Glasgow. In all cases No. 1 foundry iron is 2s. 6d. per ton more than No. 3, and No. 4 foundry and No. 4 forge are 1s. per ton less than No. 3.

Activity in the East Coast hematite market has fallen away, but this has occasioned little anxiety on the part of the makers, who are well booked forward. The continued firmness of raw-material prices has occasioned fresh discussion on the possibility of an upward move in hematite quotations. For the time being, however, prices continue to be based on No. 1 East Coast hematite at 68s. per ton delivered Middlesbrough, 75s. per ton delivered Scotland, 76s. delivered Lancashire, and 79s. delivered Birmingham.

LANCASHIRE.—Deliveries of pig-iron into this area have been largely suspended as the result of the holidays in many districts. There has been no change in quotations. For delivery to consumers in the Lancashire zone, offers of Derbyshire, Staffordshire and Cleveland No. 3 are all on the basis of 74s. per ton, with Northamptonshire at 72s. 6d. Offers of Scottish No. 3 for delivery in the Manchester area are at around 82s. 6d. per ton.

MIDLANDS.—Deliveries of pig-iron from the furnaces to the ironfounders during July came to a very satisfactory total, increased tonnages being specified in view of the holiday period. The stoppage this year is a short one, particularly in the light-castings trade, which continues to be very active. The controlled prices for Midland brands of iron, delivered to Birmingham and Black Country stations, are unaltered at 67s. 6d. for Northants No. 3 and 71s. for Derbyshire, Lincolnshire and Staffordshire No. 3, these figures being subject to a small sliding-scale rebate to large consumers. Prices for better grades of iron for engineering work are very firmly quoted. Scottish iron is at about 85s. to 87s. 6d., at which figure other low-phosphorus irons are obtainable; medium-phosphorus irons are at from 75s. to 80s., and special refined pig from £5 10s. to £6 15s. per ton.

SCOTLAND.—There continues to be only a limited demand for Scottish foundry iron, which remains at the official minimum of 70s. f.o.r. furnaces for No. 3, with 2s. 6d. extra for No. 1. Founders in the Falkirk and Larbert districts are actively engaged. There is no change to be reported in the official prices of Cleveland No. 3, *i.e.*, 67s. 3d. f.o.r. Falkirk and 70s. 3d. f.o.r. Glasgow.

Coke

The foundry-coke market remains very firm. The majority of consumers have taken cover until the end of the year, beyond which the ovens are not prepared to book. Current quotations for delivery in the Birmingham area are as follow:—Best Durham coke, 36s. to 40s., with other qualities down to 35s.; Welsh coke, 37s. 6d. to 45s.; Scottish coke, 40s. to 41s. per ton.

Steel

Although holiday conditions rule in the iron and steel markets, a confident feeling generally prevails. A further increase in the already high rate of activity is anticipated when the autumn demand sets in. There is a good demand for semi-finished steel, but severe competition in this department has been experienced lately from the Continental manufacturers. A sufficient number of orders for semi-finished steel to tide them over the holiday season is held by the producers. While the demand continues to be mainly from domestic consumers, there has lately been an increased overseas inquiry, and it is hoped that this autumn will see a long-overdue expansion of trade with foreign consumers.

Scrap

Business in scrap iron has generally been quiet throughout the country. In the Cleveland area, quotations are 50s. for ordinary heavy metal and 52s. 6d. for machinery scrap, broken to handy sizes. There continues to be a steady demand for scrap iron in the Midlands, heavy machinery metal being at 55s. delivered, good heavy pipe and plate at 50s. and clean light metal at 47s. 6d. The South Wales demand for scrap is very dull, heavy cast iron being nominally quoted at 45s. to 47s., light cast-iron scrap at 40s. to 41s. and good cast-iron machinery scrap at 50s. to 52s. 6d., sales of the latter being confined to a few odd truck-loads. Similar conditions prevail in Scotland, where it is difficult to dispose of machinery cast iron, in pieces not exceeding 1 cwt., at 55s. per ton. Ordinary cast iron to the same specification is at 51s. 6d. to 52s. 6d.

Metals

Copper.—Business has been quiet in the copper market, the demand from consumers having fallen away in accordance with the season. Even at the low prices at present ruling consumers show little inclination to buy.

Daily market prices:—

Cash.—Thursday, £28 15s. to £28 16s. 3d.; Friday, £28 17s. 6d. to £28 18s. 9d.; Tuesday, £29 5s. to £29 6s. 3d.; Wednesday, £28 12s. 6d. to £28 13s. 9d.

Three Months.—Thursday, £29 2s. 6d. to £29 3s. 9d.; Friday, £29 5s. to £29 6s. 3d.; Tuesday, £29 12s. 6d. to £29 13s. 9d.; Wednesday, £29 to £29 1s. 3d.

Tin.—The statistics published on the first day of the month showed an increase in the total visible supply of tin of about 500 tons. The market is at the moment rather sluggish. The industrial demand for tin in this country has been limited, and reports from the Continent and the United States also indicate quiet conditions.

Price fluctuations:—

Cash.—Thursday, £228 15s. to £228 17s. 6d.; Friday, £228 12s. 6d. to £228 15s.; Tuesday, £227 10s. to £227 15s.; Wednesday, £227 5s. to £227 10s.

Three Months. — Thursday, £228 15s. to £228 17s. 6d.; Friday, £228 12s. 6d. to £228 15s.; Tuesday, £227 10s. to £227 15s.; Wednesday, £227 7s. 6d. to £227 10s.

Spelter.—The slackness of the demand for this metal is reflected in the low prices which have recently prevailed. A recovery is unlikely until some measure of increased activity is seen in the galvanising trade.

Day-by-day quotations:—

Ordinary. — Thursday, £13 10s.; Friday, £13 13s. 9d.; Tuesday, £13 12s. 6d.; Wednesday, £13 11s. 3d.

Lead.—The demand for lead has held up very well, in view of the holiday. Good deliveries have been taken by consumers, there being some fears of a shortage of supplies.

Price fluctuations have been as follow:—

Soft Foreign (Prompt).—Thursday, £11 1s. 3d.; Friday, £10 18s. 9d.; Tuesday, £10 17s. 6d.; Wednesday, £10 15s.

Contracts Open

Bradford, August 17.—Iron and steel stores, for the Gas Committee. Mr. G. E. Currier, deputy gas engineer, Britannia House, Bradford.

Braunton, August 10.—400 yds. cast-iron pipes, for the Barnstaple Rural District Council. Mr. H. Hargreaves, sanitary inspector, The Red House, Castle Street, Barnstaple.

Argentina, September 12.—Cast-iron pipes and valves, for the Sanitation Department of the Province of Buenos Aires. The Department of Overseas Trade. (Reference G.Y. 14,094.)

Above Derwent, August 16.—Provision and laying in Above Derwent of 180 yds. 6-in. C.I. spun pipes, 3,615 yds. 4-in. concrete-lined spun-iron pipes, with valves, etc., for the Cockermouth Rural District Council. Mr. A. E. Simpson, engineer to the Council, Grecian Villa, Cockermouth.

Baydon, etc.—For the Hungerford Rural District Council. Contract No. 5—provision and laying of 3,500 yds. of 6-in. and 3-in. steel pumping mains; 30,130 yds. of 6-in., 5-in., 4-in. and 3-in. spun-iron mains; 15,750 yds. of 4-in. and 3-in. asbestos-cement mains; 3,050 yds. of 2-in. cast-iron branches, with valves, etc. Mr. G. P. Hewett, clerk, Council Offices, Hungerford, Berks. (Fee £3, returable.)

Review of World Trade, 1933

According to the Review of World Trade for 1933, which has just been published by the Economic Intelligence Service of the League of Nations, the fall in the quantum of international trade, which set in with the economic depression nearly five years ago, was arrested in 1933 when a slight increase occurred. The value of world trade was, however, lower than in 1932 by 10 per cent. in terms of gold and by 5 per cent. in terms of sterling. The increase in trade activities was almost entirely due to raw materials, the quantum of which entering into trade is estimated to have risen from 1932 to 1933 by as much as 8 per cent. Average prices of goods entering into trade fell from 1932 to 1933 by 11-12 per cent. in gold and 7 per cent. in sterling. Exports of the United Kingdom, Japan and a number of smaller industrial countries, rose in quantum in 1933; on the other hand, the quantum of German exports fell off. From the middle of the year United States trade (imports as well as exports) experienced a marked improvement. This publication is obtainable from Messrs. Allen & Unwin, (League of Nations Publications Department), 40, Museum Street, W.C.1. (Price 2s. 6d.).

CAST IRON FLANGED PIPES
2 in.–12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone: 3852 (2 Lines). MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

An impossible position

but—

Armstrong Whitworth "New Process" Refined Iron provides the Ideal Base for the Perfect Casting.

There is a Grade of "New Process" Iron for every type of casting.

Write for our Brochure No. 518: it is full of valuable data.

ARMSTRONG CLOSE WORKS — WHITWORTH GATESHEAD ON TYNE

W. G. ARMSTRONG WHITWORTH & Co. (IRONFOUNDERS) LIMITED. SIR W.

Telephone: Gateshead 71181. *Telegraph: "Closework, Gateshead-on-Tyne."*

RAW MATERIALS—PRICE LIST

(Wednesday, August 8, 1934)

COPPER

	£	s.	d.
Standard cash	28	12	6
Three months	29	0	0
Electrolytic	31	15	0
Tough	30	15	0
Best selected	31	5	0
Sheets	58	0	0
India	41	5	0
Wire bars	32	5	0
Ingot bars	32	5	0
H.C. wire rods	34	15	0
Off. av. cash, July	29	15	0
Do., 3 mths., July	30	2	1 1/16
Do., Sttlmnt., July	29	15	0
Do., Electro, July	33	0	0
Do., B.S., July	32	13	0 3/4
Do., wire bars, July	33	4	5 7/16
Solid drawn tubes			9½d.
Brazed tubes			9½d.
Wire			6¼d.

BRASS

Solid drawn tubes	8½d.
Brazed tubes	10½d.
Rods, drawn	8½d.
Rods, extd. or rlld.	4½d.
Sheets to 10 w.g.	7d.
Wire	7½d.
Rolled metal	6½d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN

	£	s.	d.
Standard cash	227	5	0
Three months	227	7	6
English	227	12	6
Bars	229	7	6
Straits	227	12	6
Australian (nom.)			—
Eastern	228	12	6
Banca	228	5	0
Off. av. cash, July	230	9	3 9/16
Do., 3 mths., July	230	1	5 1/16
Do., Sttlmt., July	230	8	10 5/16

SPELTER

	£	s.	d.
Ordinary	13	11	3
Remelted	14	5	0
Hard	11	5	0
Electro 99.9	16	2	6
English	14	5	0
India	13	5	0
Zinc dust	16	10	0
Zinc ashes	3	0	0
Off. aver., July	13	11	7 1/16
Aver. spot, July	13	9	3 9/16

LEAD

	£	s.	d.
Soft foreign ppt.	10	15	0
Empire (nom.)	11	12	6
English	12	10	0
Off. average, July	10	18	6 3/32
Average spot, July	10	16	3

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	23	5	0
Do., V.M. ex whse.	21	12	6
Rods	27	10	0

ANTIMONY

	£	s.	d.		£	s.	d.
English	40	0	0	to	43	0	0
Chinese, ex-whse.					36	10	0
Crude					24	0	0

QUICKSILVER

	£	s.	d.		£	s.	d.
Quicksilver	11	0	0	to	11	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£8 17 6
45/50%	£13 0 0
75%	£18 7 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	5/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten—	
80/85%	3/3 lb.
Tungsten metal powder—	
98/99%	3/6 lb.
Ferro-chrome—	
2/4% car.	£29 15 0
4/6% car.	£23 0 0
6/8% car.	£21 12 6
8/10% car.	£21 12 6
Ferro-chrome—	
Max. 2% car.	£36 0 0
Max. 1% car.	£38 15 0
Max. 0.70% car.	£42 0 0
70%, carbon-free	10d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/3 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	2	13	0	to	2	15	0
Bundled shrngs.	2	5	6	to	2	7	6
Mixed iron and steel	2	8	0	to	2	9	0
Heavy cast iron	2	5	0	to	2	7	0
Good machinery	2	10	0	to	2	12	6
Cleveland—							
Heavy steel			2	10	0		
Steel turnings			1	17	6		
Cast-iron borings			1	7	6		
Heavy forge			2	10	0		
W.I. piling scrap			2	5	0		
Cast-iron scrap	2	10	0	to	2	12	6
Midlands—							
Light cast-iron scrap			2	7	6		
Heavy wrought iron			2	17	6		
Steel turnings, f.o.r.			1	12	6		
Scotland—							
Heavy steel	2	10	0	to	2	11	0
Ordinary cast iron	2	11	6	to	2	12	6
Engineers' turnings			2	0	0		
Cast-iron borings			2	0	0		
Wrought-iron piling			2	10	0		
Heavy machinery			2	15	0		

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	25	0	0
Brass	17	10	0
Lead (less usual draft)	9	10	0
Tea lead	7	0	0
Zinc	9	0	0
New aluminium cuttings	69	0	0
Braziery copper	22	0	0
Gunmetal	23	0	0
Hollow pewter	145	0	0
Shaped black pewter	110	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	68/-
Hematite M/Nos.	67/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	71/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	80/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/6
Clyde, No. 3	82/6
Monkland, No. 3	82/6
Summerlee, No. 3	82/6
Eglinton, No. 3	82/6
Gartsherrie, No. 3	82/6
Shotts, No. 3	82/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	9	12	6	to	9	15	0
Nut and bolt iron	7	10	0	to	8	0	0
Hoops	10	10	0	and up.			
Marked bars (Staffs) f.o.t.	12	0	0				
Gas strip	10	10	0	and up.			
Bolts and nuts, ¾ in. × 4 in.	14	0	0				
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	8	0	0	to	8	10	0
Chequer plts.			10	7	6		
Angles			8	7	6		
Tees			9	7	6		
Joists			8	15	0		
Rounds and squares, 3 in. to 5½ in.			9	7	6		
Rounds under 3 in. to ⅝ in. (Untested)			8	12	0		
Flats—8 in. wide and over			8	12	6		
,, under 8 in. and over 5 in.			8	17	6		
Rails, heavy	8	5	0	to	8	10	0
Fishplates	12	5	0	to	12	10	0
Hoops (Staffs)			9	7	0		
Black sheets, 24g. (4-t. lots)			10	10	0		
Galv. cor. shts. (,,)			13	0	0		
Galv. flat shts. (,,)			13	10	0		
Galv. fencing wire, 8g. plain			14	10	0		
Billets, soft			5	10	0		
Billets, hard	6	17	6	to	7	2	6
Sheet bars	5	0	0	to	5	7	6
Tin bars	5	2	6	to	5	7	6

PHOSPHOR BRONZE

	Per lb. basis.
Strip	9d.
Sheet to 10 w.g.	10d.
Wire	11½d.
Rods	10d.
Tubes	13d.
Castings	11d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Bessemer	20.76
Malleable, Valley	18.50
Grey forge, Valley	18.25
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	20/-
Durham foundry	21/- to 25/-
,, furnace	17/6
Midlands, foundry	—
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes 20×14 per box	18/-
,, 28×20 ,,	36/-
,, 20×10 ,,	26/-
,, 18¾×14 ,,	18/7½
C.W. 20×14 ,,	15/9
,, 28×20 ,,	33/3
,, 20×10 ,,	22/6
,, 18⅝×14 ,,	15/9

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.		£	s.	d.
Pig-iron	6	0	0	to	7	0	0
Bars-hammered, basis	16	0	0	to	16	10	0
Bars and nail-rods, rolled, basis	15	15	0	to	16	0	0
Blooms	10	0	0	to	12	0	0
Keg steel	30	0	0	to	31	0	0
Faggot steel	18	0	0	to	23	0	0
Bars and rods dead soft, st'l	10	0	0	to	12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.		
Aug.	2 ..	28	15	0	inc.	1/3
,,	3 ..	28	17	6	,,	2/6
,,	7 ..	29	5	0	,,	7/6
,,	8 ..	28	12	6	dec.	12/6

Electrolytic Copper

		£	s.	d.		
Aug.	2 ..	31	15	0	No	change
,,	3 ..	32	0	0	inc.	5/-
,,	7 ..	32	5	0	,,	5/-
,,	8 ..	31	15	0	dec.	10/-

Standard Tin (cash)

		£	s.	d.		
Aug.	2 ..	228	15	0	dec.	5/-
,,	3 ..	228	12	6	,,	2/6
,,	7 ..	227	10	0	,,	22/6
,,	8 ..	227	5	0	,,	5/-

Tin (English ingots)

		£	s.	d.		
Aug.	2 ..	228	17	6	dec.	7/6
,,	3 ..	228	17	6	No	change
,,	7 ..	227	17	6	dec.	20/-
,,	8 ..	227	12	6	,,	5/-

Spelter (ordinary)

		£	s.	d.		
Aug.	2 ..	13	10	0	inc.	2/6
,,	3 ..	13	13	9	,,	3/9
,,	7 ..	13	12	6	dec.	1/3
,,	8 ..	13	11	3	,,	1/3

Spelter (Electro, 99.9 per cent.)

		£	s.	d.		
Aug.	2 ..	16	2	6	inc.	2/6
,,	3 ..	16	5	0	,,	2/6
,,	7 ..	16	2	6	dec.	2/6
,,	8 ..	16	2	6	No	change

Zinc Sheets (English)

		£	s.	d.		
Aug.	2 ..	23	5	0	No	change
,,	3 ..	23	5	0	,,	,,
,,	7 ..	23	5	0	,,	,,
,,	8 ..	23	5	0	,,	,,

Lead (English)

		£	s.	d.		
Aug	2 ..	12	15	0	No	change
,,	3 ..	12	15	0	,,	,,
,,	7 ..	12	15	0	,,	,,
,,	8 ..	12	10	0	dec.	5/-

AVERAGE MONTHLY PRICES OF STEEL RAILS

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1919	10 17 6	13 7 6	13 7 6	13 7 6	15 0 0	15 10 0	16 0 0	16 10 0	16 10 0	16 10 0	16 10 0	17 5 0	14 12 11
1920	18 15 0	19 5 0	20 7 6	22 0 0	23 0 0	23 0 0	24 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	22 18 11½
1921	23 5 0	20 4 0	18 0 0	17 0 0	15 0 0	15 0 0	14 0 0	14 0 0	14 0 0	11 12 6	10 10 0	10 0 0	15 4 3
1922	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 0 0	8 15 0	8 15 0	8 15 0	8 15 0	9 4 2
1923	8 17 6	9 2 0	10 5 0	10 10 0	10 10 0	10 10 0	9 15 0	9 0 0	8 15 0	8 15 0	8 19 0	9 5 0	9 9 10
1924	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 2 6	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 2 3½
1925	9 0 0	9 0 0	9 0 0	9 0 0	8 15 0	8 10 7½	8 10 0	8 10 0	8 10 0	8 4 0	8 0 0	8 0 0	8 11 7½
1926	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 10 0	8 3 11½
1927	8 10 0	8 10 0	8 10 0	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 3 0	8 5 0	8 5 0	8 4 10
1928	8 5 0	8 5 0	8 5 0	8 5 9	8 6 3	8 6 3	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 7 9½
1929	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1930	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1931	8 9 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 8
1932	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1933	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1934	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	—	—	—	—	—	—

AVERAGE MONTHLY PRICES OF EAST COAST HEMATITE AT MIDDLESBROUGH

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1918	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1919	122 6	122 6	122 6	122 6	179 2	190 0	197 6	200 0	200 0	200 0	200 0	200 0	171 4
1920	220 0	220 0	240 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	251 8
1921	240 0	220 0	180 0	180 0	180 0	160 0	160 0	160 0	137 0	127 6	117 6	104 6	162 2
1922	97 6	91 7½	100 0	98 6	97 1½	94 7	93 6	90 9	89 7	91 10½	93 0	93 2	94 5½
1923	94 6	104 9	122 0	126 10½	122 0	115 3	107 0	98 8½	98 10½	99 1½	100 6½	102 3	107 10½
1924	102 4½	101 3	99 7½	99 0	98 9½	97 4½	95 3½	93 1½	90 7½	88 0	88 4½	88 6	95 2½
1925	87 5	85 9	84 7½	82 6	80 10½	79 3	77 1½	75 7½	75 0	74 3½	74 9	76 0	79 5½
1926	77 3	77 9	77 3½	76 3	77 4½	78 0	79 8½	81 9	83 4½	87 7½	92 6	90 5½	81 7½
1927	90 ·	90 0	86 3½	83 1½	80 6	78 0	76 6	75 4½	75 0	72 9	71 9	71 1½	79 2½
1928	69 7½	69 7½	69 9	70 0	70 0	69 3	68 7½	69 2	70 0	70 0	70 3	71 0	69 9½
1929	71 6	72 0	73 6	74 0	74 0	74 1½	74 9	75 6	76 1½	76 8½	78 1½	79 0	74 11½
1930	78 2½	78 0	76 9	75 0	74 0	72 7½	71 0	71 0	71 0	71 0	70 10½	70 4½	73 3½
1931	70 0	69 0	68 0	66 8½	65 1½	63 4½	62 9	61 1½	65 0	65 0	65 0	65 0	65 6
1932	64 10	64 3	63 6	63 6	63 6	62 7½	62 0	60 6	60 0	59 3	59 0	59 0	61 10
1933	59 0	59 0	59 0	59 0	59 0	59 0	59 0	59 0	59 3	60 7½	62 6	62 6	59 8½
1934*	62 6	65 0	67 6	67 6	67 6	67 6	67 6	—	—	—	—	—	—

* Since March, 1934, delivered works; previously f.o.t. furnaces.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

LIMPET

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

Notice

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(A remittance should accompany instructions.)

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